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THE RELATIONS OF FINANCE TO INDUSTRIAL SUCCESS.

By Henry Clews.

IN considering the great subject of industrial enterprises, the first thing that naturally strikes the financier as well as the prudent man of general business is the character of the financial management of these institutions.

The absolute necessity of financial foresight has been emphasized time and time again, when concerns built up and guided by undoubted mercantile ability have had bright prospects destroyed through the lack of experienced financial management at a critical time.

The danger in a growing business lies chiefly in the temptation to expand too rapidly. There must be reason in all things, and in no case will that apply with better force than here. A strong nature and a cool head are indispensable in the case in point. The merchant or tradesman who commences on small capital, and who finds, after a time, that his executive and managing abilities are bringing in a constant accession of business, must very carefully watch the increase of liabilities; otherwise, the time of stringency coming will find him unprepared to meet his demand obligations, and the results of perhaps many years will be swept away. His engagements must be so arranged that every one can be provided for at maturity, considering carefully also the element of possible variation or diminution of trade.

The great currency agitation of the present time calls for the utmost care and deliberation on the part of every business man. He must be careful not to rear a top-heavy structure at any time. The weight must surely fall. His notes or other obligations come due, and, if he be without means to meet them, he is forced to the wall.

The more attentively and closely this subject is examined, the more clearly does it appear that the place of financial management in the

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industrial organization largely determines its success or failure. The power and ability of the capital to increase are liable to be crippled in every attempt at augmentation, if the financial management is slow to perceive the requirements for this purpose. The surplus must be carefully watched, and not wasted in superfluous or personal expenses, for it is through the persistent operation of the law of aggregation working upon the surplus that the industrial concern achieves its great development and expansion.

Not the least important feature resulting from prudent, honest, and capable management is its advantage in preventing State interference, beyond the limits of salutary supervision, and its potency to leave no excuse for State control, which, in my opinion, might prove destructive of the highest aims of the legitimate Industrial, and deprive it of its greatest potentialities, either in the interest of the commonweal or the private-enterprising individual.

Too often, however, the management is faulty, the principal errors, I am inclined to think, being over-capitalization and a disinclination on the part of the management to make periodical statements of the condition. In other words, the quality of success which appears to be inherent in these quasi public concerns seems to be at the root of a great deal of their trouble, and a perpetual source of annoyance to their stockholders, and to all who happen to invest in their securities, with the exception of the favored few who are in the confidence of the secret management, and who have, therefore, generally a sure thing on a share of the usually large profits.

A large amount of this trouble would be avoided if the management were forced to make periodical statements, as national banks, railroad companies, and other quasi-public institutions are. This duty should be made mandatory, and equitably so, because such companies are given public privileges, and public obligations are implied, if not positively stated, in the contract between them and the public.

The fact that Industrials are possessed of double attributes and have functions of a public and a private nature combined opens the way to abuse of official power, and this may frequently occur with an honest purpose in view,—an intense desire to assert private independence against what may be regarded as public intermeddling with private affairs. An inability to perceive fine distinctions between obligations of this dual character, and the natural tendency in human nature to follow the selfish purpose in the first instance, may lead to official delinquency toward public interests, where the original intention was only a matter of self-assertion or a sensitive desire to stand upon personal dignity and personal rights. But, after such a habit of action has been some time indulged, it may assume a grosser as-

pect, in which delicacy of feeling and lofty notions of self-respect may play but little part, the change in the man's nature, or the management's nature and principles, having been wrought through an appeal to sharp avaricious propensities, finally so blunting the perceptions that he or they become incapable of drawing a distinction between *meum* and *tuum*. I have seen some very fine specimens, apparently, of worthy manhood and high principle so transformed by the seductive power of avarice that they have seemed to utterly forget the high and mighty purpose with which they set out to make an honorable career, and have entered greedily into the game of grab, ignoring all rules of rectitude and recklessly following the sentiment of the kingly maxim, "After us, the deluge."

Unfortunately, such a spirit pervades the management of many of these Industrials, and, in consequence of it, they have been viciously deflected from their true intent and purpose. This has sometimes occurred through ignorance of the end in view, forgetting that to aim at the greatest good is often the best means of attaining one's own individual benefit. But avarice is seldom capable of adapting this broad view, so that this vice is the greatest with which the Industrials have had to contend; and nothing can prevent it from invading both public and private rights, except the strong arm of the law.

I have no contention with those who hold the doctrine of moral suasion in cases of this kind, but I am now considering the practical phase of the subject, in which nothing but material correction, which appeals to the physical senses, has been found practically effective in business and social experience, and produced any tangible results. Of course, the moral sense is an important function to cultivate in maintaining the laws of society and business equity, but where this quality becomes very oblique, as in many cases of Industrial management, the ends of justice require firmer measures.

In plain terms, it is utterly useless to preach the moral law to a man who has an idea that he is doing a meritorious act in laying schemes to plunder his neighbor in a way that the latter cannot prove, the methods adopted being such as the public have been taught to think of as genuine and honest. Nor will the doctrine of passive obedience help that neighbor to assert his rights. It will only render him more liable to be victimized.

These industrial institutions, which had their real origin centuries ago in the corporations of Rome when that nation was mighty, long prior to its corruption and downfall, were organized with the purpose of conferring higher benefits upon the community and private individuals than could possibly accrue from individual effort.

Thus the corporate or industrial idea in its early conception, and

when put in operation according to the present conception, was and is calculated to confer the greatest benefits on humanity that human ingenuity and energy can bestow. It is the most effective instrument for moving the forces that produce wealth and happiness—because there is no happiness in poverty, or morality in destitution, no matter what preachers may say—that has ever been discovered or invented by man. The existence of the corporation is absolutely necessary in this age of progress and development to give all other inventions a chance of exhibiting their capacity and of conferring their illimitable boons and blessings upon mankind. It enables an aggregation of individuals to put their capital and energy together, so as to act as one gigantic power, overcoming obstacles that by any other means would be inconquerable. It is the practical faith in our day that removes mountains.

But still this huge giant can be temporarily crippled, shackled, and subdued by the vile demon of avarice to which I have just referred.

The periodical examinations of the financial management of all industrial properties, on which I have frequently written, can be made so effective as to keep the plunder out of the way of the ultra-avaricious individual, or, if he shows an irresistible desire to meddle with it, to immediately suppress him by the strong arm of the law.

I admit that this treatment is suggestive of very radical measures, but that "desperate cases require desperate remedies" is a medical adage applicable to these business maladies.

Now comes the most delicate part of my task in stating these views in a public magazine through which they will reach a large and intelligent audience,—that is, to individualize. There is no use in firing bullets in the air and losing ammunition upon game beyond our range. We must cite cases in point, or our glittering generalities are like the idle wind. We must point out the very concerns in which the faulty financial management exists, or our labor is in vain. Without beating further around the bush then, a few of the most conspicuous of these are briefly termed, in the every-day language of the Stock Exchange, "Tobacco," "Leather," "Whiskey," and "Cordage."

Now, if these, and others similar to them, had originally all been put through the ordeal of a thorough investigation at their start by expert accountants, and their true financial condition laid before the public, serious losses would have been prevented from falling upon innocent and worthy people, and the corporations themselves saved from the reproaches now heaped upon them by the victims.

Some people draw a distinction between dishonest and unwise methods in the financial management of these properties. Many of the methods are unwise, though not dishonest and criminal, and ultimately wreck the property.

Among the railroad list furnishing illustrations of faulty financial methods may be cited Baltimore & Ohio, Reading, Atchison, Northern Pacific, Union Pacific, and many more. Many such properties have exhibited peculiar methods, if not delinquencies, in book-keeping, which should have been far more rigidly investigated than they were.

The recent investigation of the Refunding Committee of the Pacific Railroads at Washington last Spring brought out most remarkable evidence from one of the principal witnesses, who stated that the books connected with the construction of the road had been burned or destroyed as useless trash, involving the superfluous expense of room-rent, though they contained the record of transactions involving hundreds of millions of dollars, which record is now absolutely necessary to a fair settlement between the government and its debtors, their heirs and assigns, who promoted that stupendous enterprise and great highway of commerce. The fact also was put in evidence that a certain party in interest had testified before another committee, on a former occasion, that he was present when $54,000,000 of profits were divided equally among four partners,—himself and three others. None of the books of record containing this valuable information escaped from the flames.

Now, under a system of public examination,—as often as once a year at least, as I have frequently proposed, and by experts trained for that special purpose and having received a collegiate education as part of their preparation,—no such evidence could be destroyed.

Developments much more incredible, and extraordinary and shocking to the mind of the expert accountant of the present day, are promised in Union Pacific. The revelations in Northern Pacific would not be less amazing, and what has yet to come in Baltimore and Ohio regarding extraordinary book-keeping only Mr. Little knows.

Under proper supervision of the financial management, the so-called Industrials would be capable of fulfilling their beneficent purpose,—to cheapen production, in order that consumers may reap the larger portion of the profits, after a fair remuneration to management and shareholders.

Though it would take volumes to ventilate this subject fully, I think the matters to which I have referred, and the means of reform which I have suggested, strike at the root of some of the worst abuses pertaining to these commercial undertakings and investments, and especially to their speculative management and the manipulation of their securities. The "scoops" which have become so frequent in speculative circles, and which have brought unmerited odium on the legitimate speculation of Wall street, would hardly be possible under the surveillance of a board of expert, honest, responsible accountants, under government supervision and open to the freest criticism.

THE FALLACY OF MUNICIPAL OWNERSHIP OF FRANCHISES.

By Frank M. Loomis.

THERE is no more vexed problem, and none more generally deemed difficult of solution, than that involved in all attempts to regulate equitably the exercise of corporate franchises. The object of this article is to demonstrate, as far as may be, that the inherent difficulty lies not so much in the complexity of the problem as in the unacknowledged unwillingness of representatives of corporate interests on the one hand, and of doctrinaire reformers on the other, to do equal and exact justice to all.

Corporate greed is responsible in great measure for the growing Socialistic tendencies of the day, and is justly credited therewith exactly in the proportion that it has exacted more than a fair return on capital invested. Such exaction is not inaptly termed "robbery under the form of law." From the beginnings of civilization capitalistic greed has provoked unlawful reprisals, until now, under the guise of Socialists, the successors of Robin Hood and his merry men are heard justifying the spoliation of the rich, and insisting with ever increasing vehemence that their proposed reprisals ought to receive the sanction of law. The day of the highwayman is past, but "robbery under the form of law" survives.

This, the method by which the monopolist, the "protected" manufacturer, the over-greedy capitalist has appropriated in times past more than his just due, has now become the favorite and a most deadly weapon of offence in the hands of a misguided people. State Socialists, Populists, Single Taxers, Free Silverites, all under different banners, and ostensibly with different aims, are yet united in devotion to the creed of Robin Hood, and, like him, profess to be, and often are, actuated by the highest sense of public duty. Deeply impressed with a sense of the unjust methods by which many capitalists have accumulated large wealth, they seek in various ways to distribute this wealth, not of course in just proportion among the original producers thereof, which would be manifestly impracticable, but indiscriminately among all members of the community, most of whom clearly have no claim, legal or equitable, to any of it. This, the very apparent vice of all communistic schemes, ought to be easily apprehended, and yet is evidently not apprehended at all by their promoters.

Seemingly, it is not perceived that taking wrongfully-acquired

property from the wrongful possessor thereof, and giving to another, not the owner, is not in any sense more justifiable than the original wrongful acquisition of such property; and this is not perceived, apparently, because of the whole community, rather than one or more individuals thereof, being the recipients, and supposedly the beneficiaries, under a Socialistic *régime*. It is a fundamental principle in the jurisprudence of all civilized countries that the wrongful possessor of property has good title thereto as against all but the rightful owner; and it will be assumed, rather than argued, in the progress of this discussion, that the people in their collective capacity, equally with an individual, ought to make good their title to any property in dispute, before assuming to take it from any one in whose possession it may be found.

Presumably no fault will be found with this assumption by those to whom this argument is primarily addressed,—those who more or less intelligently advocate the communal ownership of such franchises as are now controlled and operated by corporations. But these gentlemen, whose avowed intention is to reduce the rates now charged by corporations for railway transportation, light, water, fuel, telegraph and telephone service, etc., will not take kindly to a suggestion that they are advocating a scheme of legalized robbery. They are distinctively reformers,—men whose motives are absolutely above suspicion. Many of them are Christian Socialists, so-called. Most of them profess, and doubtless believe themselves to be actuated by, purely altruistic motives. They are violently opposed to what, in the phrase of the day, is termed degrading individualism, and to "selfish" competition; they advocate collectivism, and what they term coöperation, and assert it to be man's first duty to work for others rather than himself.

To characterize such men as robbers may, at first blush, seem highly presumptuous. Yet, if it be made to appear that their scheme involves a fine disregard of *meum* and *tuum*, and that their proposed benefactions are of things which are not theirs to give, the characterization may not seem so absolutely inappropriate.

To the writer the argument of these reformers seems to be lacking even in plausibility. Reasoning from the certain premise that the larger corporations are practically monopolies, and that their charges, uninfluenced and unregulated by competition, are grossly exorbitant, the inference is drawn, not that the charges ought to be regulated and limited, but that the people ought to own and share in the profits realized from the use of the corporate franchises.

This is an obvious *non sequitur*,—so obvious, indeed, that many who advocate municipal ownership, and yet are not prepared to go

the whole length of the Socialistic programme, seek to justify their position by distinguishing certain municipal monopolies as "natural" in contradistinction to other monopolies which by necessary implication are classed, therefore, as unnatural or artificial. The municipal monopoly, like all others, being a corporation, or a body having semi-corporate powers, it is not, of course, contended by our would-be reformers that such monopoly is "natural" in the sense that it is not, like other monopolies, the creature of law absolutely dependent upon favorable legislation for the exercise of its functions. The argument, in effect, is simply that in a crowded city space limitations do not as easily admit of competition between rival railway, gas- and electric lighting companies, and perhaps some others, as in the open country. But this condition furnishes at most only an additional reason for regulating the doings of the municipal monopoly. It does not prove, or tend to prove, that a municipality cannot control effectively the exercise of a franchise within its corporate limits by the same methods that are found efficacious for the control of other monopolies, and is very far from proving that municipal ownership is the only, or the best, remedy. It is by no means contended here that there is no alternative but to submit to unrestricted corporate rule; but, before considering what the writer deems the true remedy for conceded ills, it is important to show more specifically than has yet been done that communal ownership of franchises, and operation of the plants connected therewith, are "robbery under the form of law." To this end it is not, relatively, very important to debate the justice of schemes, such as are occasionally proposed, to supplant existing corporations by establishing municipal plants and operating them without profit, or at such a small rate of profit as to make competition by the corporation impracticable. It may well be that a corporation can be robbed in this or some other like way, and to the extent that this is feasible it ought to be deprecated. But a much more important and vital aspect of this question is presented by the consideration that communal ownership and exercise of franchises has the effect of enabling the non-productive or least-producing class of the community to live on the producers. The shibboleth of all advocates of municipal ownership is "cheapness,"—a thing good in itself, but, if secured by enforced contributions from the tax-payers to the support of the "tax-eaters," as certainly robbery as were the alleged depredations of Robin Hood of old.

In this connection it becomes important to understand, first of all, that it has never been shown, and in the very nature of things never can be shown, that the public can manufacture a better article or render better service at a less cost than a private corporation or an

individual capitalist. The latter are impelled by self-interest, the strongest motive known to human nature, to manufacture as cheaply as possible. On the other hand, the average office-holder is proverbially indifferent to the cost of anything which is to be paid for by a draft on the public treasury. It may be conceded that statistics all but innumerable show that gas, electricity, water, and street-railway service are oftentimes furnished to the people at a less price, and sometimes of a better quality, by the municipality than by the private corporation. But these statistics prove little or nothing as to the relative cost of production; and in many cities—like Philadelphia and Buffalo, for instance—the municipal product is far from satisfactory. A favorite method of compiling the statistics is to estimate the cost of the original investment for the municipal plant as nothing, on the theory that, when the money needed therefor is obtained from a sale of the municipal product, the charge to the people for such product, like a protective tariff, is not a tax. It is doubtful, also, whether the municipal bookkeeping on which these statistics are based takes any account of interest on investment, of repairs and renewals, of damages paid on account of accidents, or of the taxes which would have been paid to the municipality by a private corporation doing the business. It is not altogether certain, either, that the figures furnished by the employees of a city are always reliable.

But, granting for argument's sake the correctness of the statistics, they prove at most what any one in his senses would have conceded at the outstart,—*viz.*, that, with the element of profit eliminated, the product can and will be sold at less charge to the consumer than if the monopolist is left free to charge his own price.

But this is elementary, and might well have been taken for granted without resort to statistics. It may as freely be granted, and might as well be argued, that, if the Socialistic programme be carried out in its entirety, the first cost of everything to the consumer will be less than under the present industrial system. If the grocer, the butcher, the baker, the tailor, the milliner, everybody, in fact, sell their wares at cost price; if, in a word, the element of profit be eliminated,—of course the charge to the consumer is less. But if, as very frequently happens, the consumer be also a producer, and is barred from any profit, it is difficult to see how he is to gain by the change of system.

So of the community which hopes to gain an advantage from the consumption or use of cheap water, gas, fuel, or other commodity manufactured or produced without profit. What is gained in one way is lost in another.

By this, of course, is not meant that the converse of the proposition is true, in the sense that any individual member of the community has re-

turned to him, directly or indirectly, the legitimate profits which he might make in any business which may be monopolized by the community as a whole. The vice of all communistic or semi-communistic schemes is that the least worthy, including the dependent class, are enabled thereby to live on the producer. In other words, it is "robbery under the form of law." Not simply in the abstract, not technically, but in a very substantial sense; and for the reason that the monopolies from which it is proposed to exclude private capital, and incidentally individual enterprise, comprise a very large and constantly-increasing proportionate part of human industry. This statement is true, in a very special sense, of the municipal ownership and operation of street railways, because of the vast capital and large number of persons employed, and because of the fact that practically all the non-productive class, and all the least productive, would profit by the "steal." It would be but idle, too, to attempt concealment of the fact that it is this widespread benefaction (so called) that lends to the scheme its chief charm to the professed altruistic reformer, whose arguments very naturally find a ready response from those who are willing to live on the fruits of others' labor. Reference has been made before to the boasted altruism of the municipal-ownership scheme, and this is the place to say plainly that it is a false pretence. There is nothing altruistic, nothing charitable, in a scheme which purposes taking by force of law from those who have and giving to those who have not,—especially when it involves no sacrifice by the would-be donors. The scheme may be collectivisim, and it certainly is Socialism, but it is as certainly *not* Christian, not "working for others" as enjoined by the author of Christianity. It may be coöperation, but it is not that voluntary cooperation which, while working primarily for self in obedience to "the first law of nature," works also for the joint good of all, constituting thereby the highest form of human endeavor.

Another objection to the communal system, which applies with special force to the municipal operation of street railways, remains yet to be stated. This objection is to the increased officialism which such a system would entail. The prospective creation of several thousand new positions in the municipal service, all of a nature peculiarly susceptible to political manipulation, is not a pleasant prospect for civil-service reformers to contemplate at a time when final victory is in sight, but not yet won. And the spoils system, as it is familiarly known, is not the only, or possibly the most objectionable, feature of an exaggerated officialism. The increased tenure enjoyed by numerous officials by virtue of statutes passed in derogation of civil-service reform principles, which prohibit their removal except upon charges and after a trial, has emboldened them to organize for the purpose of

influencing legislation favorable to their interests as a class. Legislation of this character, increasing salaries, granting frequent holidays, etc., is crowded through the legislature with ever-increasing frequency each year.

The prospect of having this class of tax-eaters immeasurably augmented by adding thousands of street-railway employees to the city's pay-roll is something more than unpleasant. It presents a grave and very serious problem for the consideration of the already over-burdened tax-payers. It brings us face to face with the problem with which Germany is struggling to-day,—a country where the Socialistic idea has probably found more general acceptance than anywhere else. There everything, or almost everything, is "official." There is much law and order, and very much in the way of taxes. Personal liberty is at a discount, and the situation in this regard is getting more intolerable every year. It will be interesting to watch the working out of the German problem from afar; but it may well be doubted whether any considerable number of Americans would willingly exchange conditions with the Germans.

This brings us directly to a consideration of the problem as Americans, which, if our traditions stand for anything, means as democrats and republicans. We hear much, in these times, of "Americanism," and, to our shame be it said, this is fast degenerating into a cant term, used without warrant to describe every shade of political belief, every new political nostrum, and by that ostentatious American, Theodore Roosevelt, even to distinguish right from wrong. We ought rather to be honest with ourselves, and, disclaiming once for all any peculiar sanctity, as a nation or a people, make good the claim to our birthright as freemen by standing up manfully for the only distinctively American principle,—equal rights for all men, special privileges or immunities for none.

It was asserted at the beginning of this argument that the inherent difficulty in solving the monopoly problem lay in the unacknowledged unwillingness of both parties to the controversy to do equal justice to all. It has been assumed throughout that the monopolist has been unjust and over-greedy, and the Socialistic solution has been deprecated as equally unjust. What, then, is meant by equal justice? It being manifestly impracticable to divide accumulated wealth in just proportion among all who once helped to produce it, the manful, the right, thing to do, instead of bemoaning what is passed and remediless, is to prevent further unjust exactions by prescribing a maximum rate of charges (varied from time to time as changed conditions may require) which shall not be exceeded by any corporation whose business is a monopoly. This must be done, if at all, by the people in their representative

capacity. That it can be done, that it is absolutely practicable, admits of no question, for the all-sufficient reason that it has been done in notable instances. The experience of our sister republic, France, under universal manhood suffrage leaves no room for doubt that this plan will prove as efficacious with street-railway and other municipal corporations as with other not less "natural" monopolies, if only the controlling power be vested in the people immediately concerned, the residents of the city within whose limits the monopoly operates, instead of, as now, in the State legislature.

Municipal control, as distinguished from legislative control, and equally distinguished from municipal ownership, is the true solution of the municipal monopoly problem. It needs scarcely to be added that the warrant for the exercise of this control, different from and in excess of what can rightfully be exercised over the individual citizen, is to be found, not in any fanciful assumption that a municipal monopoly, more than any other, is "natural," but in the fact that it has been created and sustained by the special privileges granted to it by the people different from and exceeding those enjoyed by individuals.

The fear sometimes expressed by the representatives of monopoly that the people in their new-found power might be unjust, and the counter-opinion of the doctrinaire reformer that the people cannot be depended upon to assert and maintain their rights, may be dismissed as equally puerile. Evidently both of these opposing opinions cannot be right; and, as evidently, both are due to a distrust of democratic institutions as the conservator of equal rights. Blindly oblivious to the teaching of all history, ancient and modern, the extremists on both sides of this question magnify the smaller faults of democracy, overlooking the one patent, all-important fact that the golden age of every nation, the age in which the rights of the people have been best protected, and real progress made, has been contemporaneous with, if not a necessary incident to, the rise of democracy. The teachings of our forefathers, the story of our unparalleled success as a nation, point to the one conclusion, and show the path which we must tread, if we would escape the snares in which others have become entangled.

FIRST PRINCIPLES IN RAILROAD SIGNALLING.

By George H. Paine.

THE conditions which thirty years ago impelled Mr. George Westinghouse toward his triumphant solution of the train-brake problems are the causes which, through the air-brake, have their effect in the Empire State, the Florida Special, the Black Diamond, and other fast expresses of the present.

In like manner, railway signalling has gone hand in hand (although, sad to say, a little behind hand) with the development of the air-brake; not by a single broad conception, but nevertheless by well-defined leaps, each of them closely identified with some remarkable gain in efficiency or increased safety in operation.

It is an interesting fact that the electro-pneumatic machine, the highest development of the art of interlocking signals and switches, is the invention of the person who invented the air-brake.

There are two distinct kinds of signalling, co-existent, but independent, on all railways. Of these *interlocking* comprises those signals that deal with trains occupying separate, but converging, tracks, and which, by an attempt to cross each other's path at the same time, would collide. Except in one or two unimportant cases, interlocking signals are always operated in connection with one or more switches, and are so arranged, mechanically, that, (*a*) no two of the signals which, if obeyed, would tend to bring trains into collision can be cleared at the same time, (*b*) all of the switches over which a train must pass are set and locked in the proper position before a clear signal can be given, and (*c*) none of the switches can be moved or even unlocked, so long as the signal which controls them remains in the clear position.

Although the practice of interlocking becomes more complicated as the demands of traffic increase, its manifestations, the signals, have been admirably simplified, until now there is but one recognized form, universally known as the *semaphore*.

The semaphore is an arm mounted on a post and pivoted at one end, so that it may rest in a horizontal position or be inclined at an angle (usually) of about 75° with the horizon. There are three kinds of semaphore,—the *home*, the *distant*, and the *dwarf*.

The home signal, Fig. 1, is used only in connection with the main tracks of a railway, and consists of an arm about five feet long mounted on a post some twenty feet above the track. A lamp is placed back of one end to illuminate it at night. When the signal is set at danger,

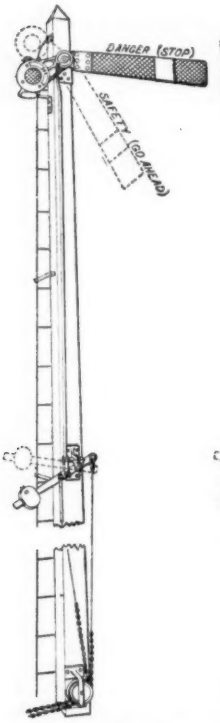


FIG. 1. HOME SIGNAL.

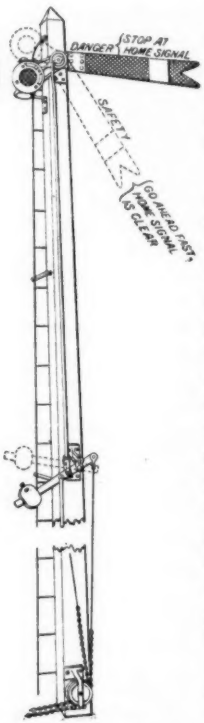


FIG. 2. DISTANT SIGNAL.

the light shines through a red glass, set in the end of the arm. When the signal is set at safety, the red glass is raised, and the light appears as white. The arm itself is usually painted red, and has a square end. The distant signal, Fig. 2, does not in itself give a positive indication, but only repeats the information rendered by the home signal, without which it cannot exist. It is of the same size as the home signal, but is usually painted green, has a "fish-tail" end, and carries a green light at night. Since its function is to repeat the information given by the home signal, it is placed from 1,200 to 2,000 feet away from it, in the direction from which trains approach. By its means, fast and heavy trains are enabled to maintain their speed up to within a certain distance from the home signal, where they receive an indication which tells them whether or not to reduce speed. It is a necessary consequence of the foregoing that the distant signal is always used in connection with main-track movements.

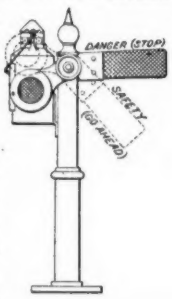


FIG. 3. DWARF SIGNAL.

The dwarf signal, Fig. 3, like the home signal, is a stop signal. The arm is painted red and has a square end, and the night indications are the same; there the resemblance ceases, for the dwarf signal is usually not more than three feet high (often much less), has an arm but twelve inches long, and is used only on side tracks, or on main tracks where trains are running in a direction opposite to that

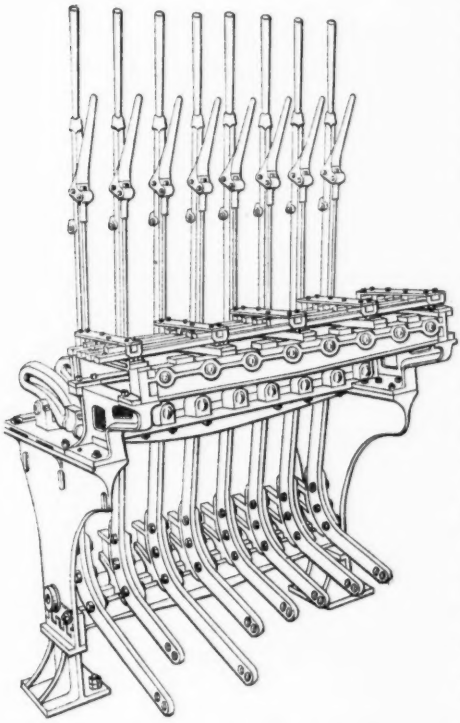


FIG. 4. MANUAL INTERLOCKING MACHINE.

which is regarded as the right one,—a thing which can occur only when there is more than one main track, for on single track trains habitually run in both directions.

These three signals are all that are used for the guidance of trains at an interlocking point. The switches and locks in the track and the signals are all connected with, controlled by, and operated from a series of levers, called a *machine*, Fig. 4, contained in a building located near the center of a plant and called the cabin, or tower. These levers are joined in a common frame and axis, and are so mechanically related by means of the *interlocking* feature proper that it is impossible for the man who moves the levers to cause a collision through the clearing of two improper signals at the same time, or to cause a derailment by means of a misplaced or unfastened switch.

In Fig. 5, W, X, Y, Z, there is illustrated the simplest form of interlocking machine. It does not contain many of the parts which are regarded as necessary in machines of the best class, but it is sufficiently complete for an explanation of the fundamental idea embodied in the term "interlocking." W is a machine of two levers, L^1 L^2, which are mounted upon a common support, S, around which, as a center, they are free to revolve, independent of each other and in a vertical plane. L^1, L^2, are connected with the cross locks, K^1, K^2, which are flat bars having indented notches in their edges opposite the

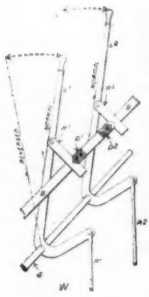


FIG. 5, W.

wedge-shaped points, D^1, D^2. D^1, D^2, are the locking dogs; they are riveted to the locking bar, B, which forces them to maintain a constant position with regard to each other. K^1, K^2, are surrounded on all four sides by guides which cause them to move in the line of their long axis, and, consequently, in the direction imparted by the movement of the lever to which each is joined. The bar, B, is placed in contact with K^1, K^2, but at right angles to them and parallel with S.

In Fig. 5, X, Y, Z, are the three positions which the levers, L^1, L^2, may hold with regard to each other when they are mutually controlled by the particular lock shown. The parts, K, B, D, are the same as in Fig. 5, W, but on a larger scale, the position of the levers being "normal" that is, forward, in W, as stated, and also in X. The object of this lock is to prevent L^1 from being "reversed" that is, pulled back, so long as L^2 is reversed, and *vice versa*. In X it is evident from the position of the notches that either K^1 or K^2 could be moved in the direction of the arrows, since B is free to move at right angles to them while they both occupy the normal position. If, now, K^2 is reversed as in Y, its notch is no longer opposite the wedge of D^2, and B is consequently held fast between K^1 and K^2 by means of D^1 and D^2, while any attempt to move K^1 (or, in other words, L^1) would prove abortive, for it is held fast by the insertion of D^1 into its notch. When, from the position X, K^1 is reversed, as in Z, K^1 forces B to move by means of its notch and the wedge on D^1; by this the wedge on D^2 is carried into the notch in K^2, which is thereby held fast in its turn. All "locks," of whatever character, are founded upon this principle, although they may take different forms and accomplish different results.

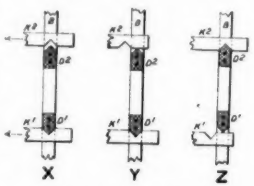


FIG. 5, X Y Z.

In Fig. 6, A, B, C, the relation which L^1, L^2, of Fig. 5, bear to a signal and a piece of track, is illustrated. Here L^1, L^2, R^1, R^2, correspond with the same letters in Fig. 5; R^1, R^2, are the rods by means of which the motion of L^1 is transmitted to F, a movable crossing frog, and the motion of L^2 to S, a signal. In A, L^1, L^2, S and F are "normal"; F is set so that the track is ready for the passage of a train from O to P, but the signal S is at danger. It is, therefore, possible to reverse either L^1 or L^2, as was explained in connection

A TERMINAL STATION WITH INTERLOCKING SIGNALS. CABIN ON THE RIGHT.

with Fig. 5, X. If, now, L^2 be reversed and the signal S be cleared, as in Fig. 6, B,—which is evidently proper, for the track is ready for a train going in that direction,—then the position of the locking will be as in Fig. 5, Y, and it will be impossible to change the position of F until L^2 has been restored to its normal position. When F has been set for a train going from M to N, as in Fig. 6, C, by the reversing of L^1, the locking on the machine will present the appearance shown in Fig. 5, Z; and, so long as that condition lasts, it is plain that neither can or should the signal S be cleared, for the track is wrong and a derailment might occur. In addition, it is likely that a train has received a clear signal to pass over the track M N, in which case a simultaneous movement past S by way of O P would cause a collision at F.

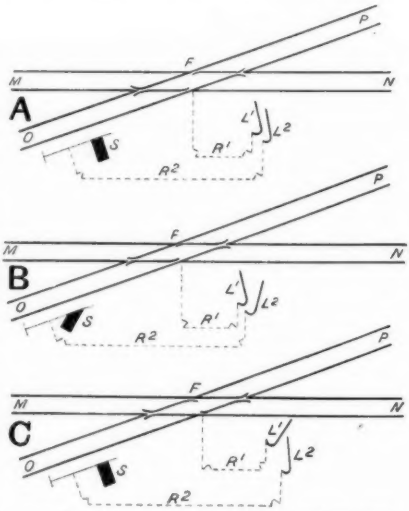
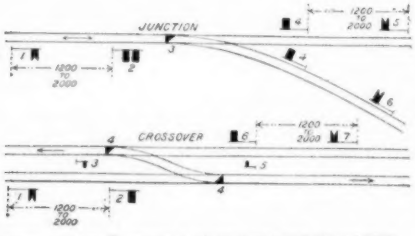


FIG. 6. RELATIONS OF LEVERS TO TRACK AND SIGNALS.

This is the service which is performed by an interlocking machine, and the means by which signal operators and engine men are prevented from making a mistake.

The applications of interlocked signals are infinite, and lie between the elementary single-track "junction" (Fig. 7) or the "cross over" (Fig. 8), and the complicated arrangement seen in Fig. 9: These sketches are the conventional way of showing at a glance the various details of an interlocking plant.



FIGS. 7 AND 8. SIMPLE INTERLOCKING PROBLEMS.

Two kinds of machine are now recognized as standard in this coun-

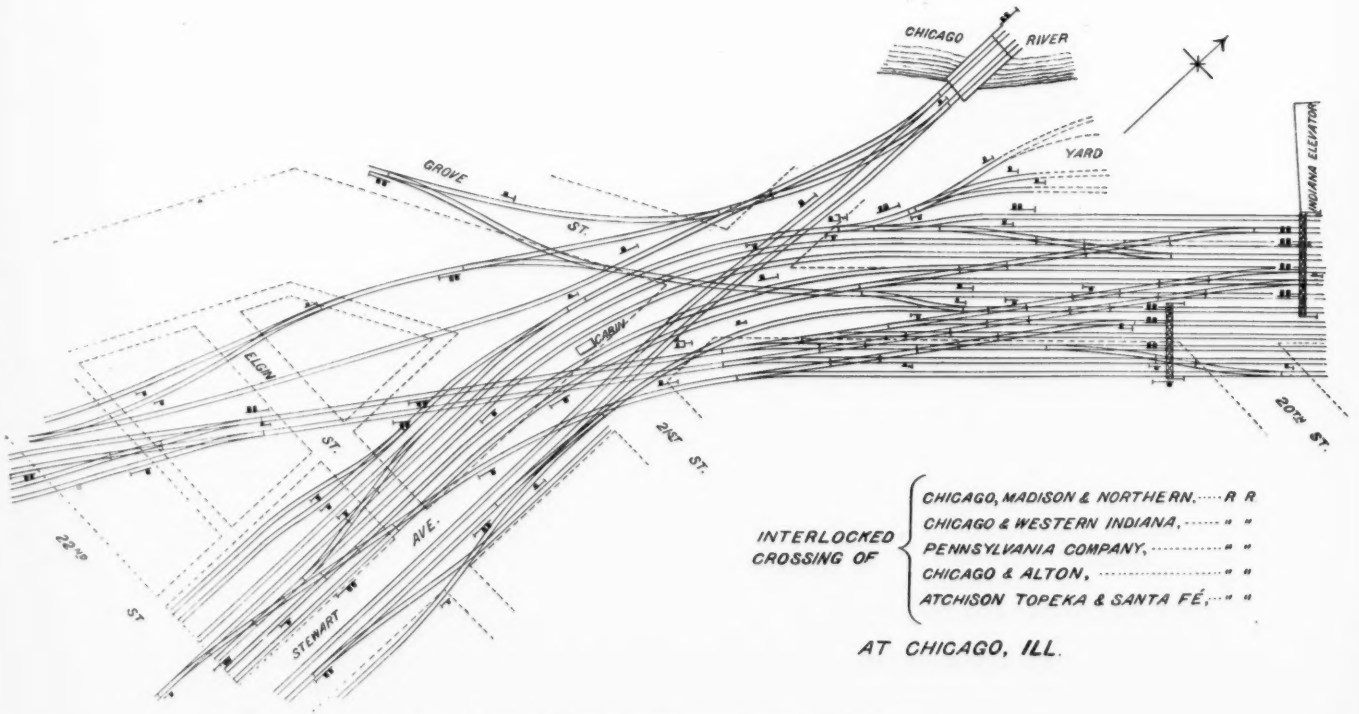


FIG. 9. A COMPLICATED CROSSING PROTECTED BY INTERLOCKING.

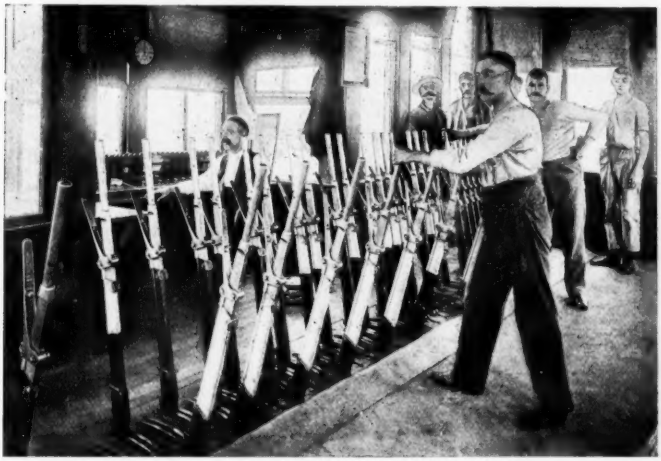
try; first and most common is the manual machine (Fig. 4), where actual man-power is used to handle the switches and signals; second, the *electro-pneumatic* machine in which, although the levers are moved by hand,—no great force being required,—the movements are performed by compressed air, and the compressed-air cylinders at the switches and signals are controlled by electro-magnets.

The levers in the manual machine are rigidly and independently connected by 1″ steel or iron (R^1, R^2, Fig. 6) pipes with the various switches, locks, and other track devices, and by pipes, or two lines of wire, with the signals. Its performance is, generally speaking, perfectly satisfactory; but, when its size passes one hundred levers or thereabout, the cost of operation becomes large. Three gangs of men are usually required in a signal cabin, each of them working eight hours: if the men receive $500 a year each, and if there are fifteen of them, the cost per year, for operators alone, in that cabin, would amount to $7,500,—not an unusual amount in plants of one hundred and fifty levers or more.

An electro-pneumatic machine, besides requiring many less levers than the manual, to accomplish a given result, enables an operator to manipulate a greater number of levers by reason of the slight effort which he need exert. One man at a time is generally enough to handle all the levers in an electro-pneumatic machine, and three men at $600 per year each—that is, $1,800—should be sufficient in all but the most exceptional cases. At all electro-pneumatic plants there must be an installation for the generation of power, consisting of boilers, engines, air-compressors, and dynamos, which increases the cost of operation, but seldom so much that in large installations the interest on the increased cost of the power over the manual plant will not be paid by the saving in operating expense, with a snug sum besides as a credit. Frequently it will be found, as, for instance, at large terminals, that nothing is required but a slight addition to the power which would be necessary in any event for lighting and heating the station, in which case the interlocking will bear only its proportion of the first cost and expense of operation, so that this part of the cost will become of still less importance in the whole scheme.

It is not now conceivable that anything will be devised which is better adapted to small isolated plants located on lines of little traffic, than a manual machine, but already it is certain that even a very small electro-pneumatic machine may be appropriate, if it forms part of a large system. Each case, however, must be decided upon its own merits, and not according to any general rule or preconceived opinion.

Curiously enough, the tendency in the United States has been to regard the claims of large and costly pieces of interlocking work almost



IN THE CABIN OF A MANUAL INTERLOCKING PLANT.

entirely to the neglect of small individual cases. Outlying cross overs, isolated switches on sharp curves where the ridiculous switch light cannot be seen more than two or three hundred feet away and the misplacing of a switch will surely cause a frightful wreck, switches at unimportant stations which are used only once a day but which are nevertheless the cause of frequent trouble, these are a few of the innumerable small matters, so far mostly ignored, which are (after the damage caused by trainmen and mistakes in telegraph orders) the origin of nearly all the horrors on a railway and yet, by a small but regular investment each year, might, on our older lines, have been entirely eliminated. Let any railway superintendent recall the number of isolated cross overs and switches on his division, determine the cost of the wrecks which have taken place at such points, and figure the cost of equipping such places with distant signals at $100 for each place, and he will be amazed to find that the expenses attending one disaster would have more than paid for total immunity.

From such small beginnings there will be a natural and healthy growth in all directions. The dependence which, it will be found, may be placed upon that silent, but untiring, sentinel, the semaphore, will gradually lead to stationing it at every dangerous and obscure place; the train men will learn that to disobey it is to endanger their own lives and the safety of their trains quite as much as if they were to ignore the presence of a red flag, frantically waved by an excited brakeman; the confidence of the officers in their men will be

A SIGNAL BRIDGE, ELECTRO-PNEUMATIC BLOCK SYSTEM.

increased, and, the real causes of disaster having been removed, the necessity for disciplinary punishment will be diminished.

But this is not all.

Where many switches must be located within a small compass, as at the entrance of a yard, there will be a palpable saving in the cost of operation, if the levers for operating them be brought together in the form of a machine, by which means one man is enabled to do the work of two or three.

The establishment of fixed signals to guard and guide the movement of trains over the switches and connecting tracks is, then, but a short step, and the surprising fact is realized that it costs less to handle the switches, colliding has become a lost art, and two switch engines are able to do the work of three under the old plan. Most surprising of all, the honest old yard-master, who has sworn all along that they would be pinned up tighter than a drum major twenty-four hours after the consecrated thing went into service, goes up into the superintendent's office after the machine has been in service a week, and says: "The cigars are on me."

It cannot be considered strange that men who have labored for a generation after a certain manner should feel a doubt as to the result of so radical a change in operating methods as is brought by the in-

troduction of an interlocking plant. This feeling is largely due to a notion that the intercourse between the train men and those who handle the switches must be a great deal closer and more frequent than is actually necessary or desirable. In order that a leverman in a signal cabin shall perform his duties satisfactorily, he need only know the track over which each train should pass, and this knowledge is easily gained.

Sometimes it is by means of electric push-buttons, located at a distance from the cabin, which are connected with an annunciator hung directly in front of the leverman, and, on being pressed, actuate the annunciator, which registers the character and destination of each train as it approaches. At other times a telephone or telegraph instrument is used ; but, whatever the conditions, no trouble is experienced in devising a plan which will not only obviate all delays, but also secure much more rapid and certain movements than are possible where the switches are not controlled from an interlocking machine.

Block signalling, although preferably carried on by signals like those which have been described in connection with interlocking, has to do with an entirely different problem. In the matter of interlocking, generally speaking, the operations are conducted in one cabin, and the object of the mechanical arrangements is to check the errors

A HIGHWAY BRIDGE USED FOR CARRYING OVERHEAD SIGNALS.

of an individual. In block signalling it is principally intended to prevent any mistakes which might occur by carelessness or oversight in the mutual relations of two or more signalmen, situated at considerable distances from each other and in separate cabins.

While interlocking is concerned, as has been stated, with trains which are upon separate, but converging, tracks, block signalling relates only to trains which are moving upon the same track. The trains may be running in the same or in opposite directions. If in opposite directions—that is, approaching or leaving each other,—it will evidently be on single track ; but, if they be running in the same direction, it may be on either single or double track, which last is a much simpler condition than the former. On double track, only trains running in the same direction need be guarded against, but on single track the question of protection is immensely complicated by having trains exposed, not only to rear collisions ("tail enders"), but to head collisions as well.

Until the more highly developed systems of block signalling are reached, the whole question is little more than a principle, an idea, and is based upon what is called the "space limit" or "space interval," which means that, if two bodies are a constant distance apart, they cannot be together and in contact. As opposed to this principle there is the "time limit" or "time interval," which, since it was born in error, nursed in ignorance, and, it is to be hoped, will soon find its death in failure, will be dismissed very shortly. The "time limit" is founded upon the belief that a train may safely leave a given point a certain number of minutes after a preceding train running in the same direction. But it is not safe for it to do so, because something may have happened to the preceding train to delay it, after it has proceeded a mile or two, and, even though the "time limit" may be half an hour, if the following train is not informed of the trouble, it will collide. This is actually what has happened, not dozens or hundreds, but thousands of times, to say nothing of the hair-breadth 'scapes. Closely allied to this is another fallacious method, which, however, has a much better excuse for its existence, and seemed to be the best at the time of its conception,—namely, "train orders," without other check than that supplied by the memory and care of the operators and despatcher. That such a plan shall be absolutely safe, there must be a guarantee that all of the men shall follow all of the rules at all times. Could this be assumed, there would be nothing to say for "blocking" trains,—that is, dividing a railway into imaginary sections called "blocks," and never permitting more than one train to occupy a certain block at any time. But, in the very nature of things, no such guarantee is possible.

It is not to supplant "train orders,"—for they must always be given in one form or another,—but as a check to these mistakes, that the block signal is most valuable, and, if properly applied, it not only is a safeguard, but increases the traffic-capacity of a piece of track.

Anything which can be seen from an engine and can be changed in its position by an operator may be used as a block signal, since its function is only to stop trains or to tell trains to go ahead. For this reason the establishment of a block system is an easy matter, and, in its simplest form, almost devoid of expense.

In Fig. 10 there is shown a piece of single track having five block stations (usually four or five miles apart, because that is the most frequent distance between railway stations on lines of moderate traffic) connected by a single telegraph or bell wire in such a way as to enable an operator in any of the cabins, A, B, C, D, E, to call up his neighbor on either hand, but not to permit any communication between the others, as, for instance, cabins A and C, or B and D. When a train approaches from X, the operator in A notifies operator B, by means of a bell code or the Morse instrument, and asks if the block A-B is clear; B in this case would answer *yes*, upon which A would notify him that he intended sending a train into the block A-B; B would then respond *correct*, *after* which A would clear his

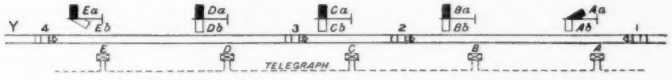


FIG. 10. TRACK EQUIPPED WITH MANUAL BLOCK SYSTEM.

signal A a, as in the drawing, permit train 1 to proceed, and immediately apprise B of the fact that it had passed his signal and entered the block. Any train, as 2, which should appear subsequently and ask for permission to enter block A-B from the opposite direction would be held at B, for both operators, A and B, would know that the block had been previously occupied, and, if one of them makes a mistake, the other will almost always detect it. In Fig. 10, the signals are semaphores, each carrying two arms, pointing in opposite directions; the arms (black) A a, B a, etc., are for trains moving from X to Y, while the white arms are for trains moving from Y to X. The arms are painted red on the side from which the trains governed by them approach, and white on the other side; this accounts for their different appearance on the sketch. To continue the operations: train 3, upon reaching C, is blocked, because train 2 is still occupying the block C-B, but train 4 finds a clear signal at E b, for the palpable reason that block E-D is vacant. This, the "plain manual" block system, although a vast advance upon any plan which does not have

as its intention the absolute separation of trains by means of a space interval, is still open to the objection that a man who is lazy or careless, by omitting to fulfill the whole schedule of acts, in asking or giving permission for the entrance of a train to a block, may contribute to a disaster. To prevent this, a method has been devised by which to control the operations between adjoining cabins. This control is accomplished by means of electric instruments attached to the signal levers in each cabin, which are alternately locked and unlocked through the medium of a series of electric wires connecting adjoining cabins. The accuracy of these instruments is such that they entirely prevent (a) an operator from clearing his signal to admit a train, so long as a preceding train occupies the block, and (b) an operator from giving an adjoining operator permission to clear his signal more than once between the passage of any two trains. As may be conceived, collisions under this plan are almost unheard of.

Lying between plain manual blocking and controlled manual blocking is a general scheme known as "automatic blocking." Of all the methods for carrying out this idea,—and they are many,—nothing has been successful so far which did not depend upon the

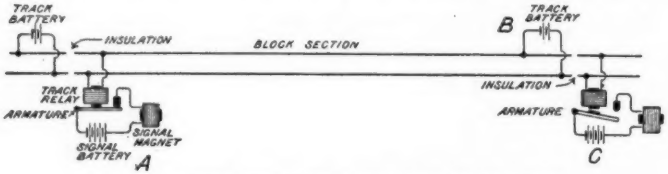


FIG. 11. TRACK EQUIPPED WITH AUTOMATIC BLOCK SYSTEM.

"track circuit" as the basis of its scheme. The "track circuit" consists in dividing a track into sections of approximately equal length, which sections (constituting blocks) have all the rails in the track on the same side electrically connected and every section electrically insulated from the adjoining one on either end. Each section has at one end a track-relay, and at the other end a track-battery, to opposite sides of which the two lines of rail are connected, much after the manner shown in Fig. 11.

A signal (not shown) is placed at the entrance to each block, and carries upon it a signal magnet. The operation is as follows. When no train is on a section, the appearance of the relay is like that at A; the current flows from one side of the track-battery B, through one line of rails, thence through the relay at A, and back again through the other line of rails to the track battery at B. By this course the track relay is magnetized, and attracts its armature, which

forms part of a circuit through the signal magnet and permits that to be magnetized in turn through the signal battery, which condition results in a clear signal at A. If a train should be on the section, the appearance of the track relay is as represented at C, and is accompanied by a danger-signal. The resistance offered to the electric current through the rails, and a pair of wheels which would electrically connect the rails, is less than the resistance offered by the track relay; wherefore the current is short-circuited, and, instead of passing through the relay, goes from the battery through the rails to the first pair of wheels, crosses over through the wheel and axle, and returns through the rails on the other side of the track to the battery again, neglecting the relay altogether. In consequence of this, the armature at C is not attracted, the circuit through the signal magnet and signal battery is broken, and the signal itself, which contains signal magnet C, remains at danger.

FIG. 12. BANJO SIGNAL.

There are three principal forms of signals which depend upon the track circuit for their control.

First is the "banjo" signal (Fig. 12), named from its fancied resemblance to a banjo, which has as its operating force the signal battery itself. This requires that the battery shall be somewhat more powerful than in the other two forms. The signal is an enclosed disc built of red or green cloth (for home or distant signals), which, when at danger, falls by gravity in front of the opening in the case, and, when at safety, is raised from in front of the opening, exposing a white background, as in the illustration.

FIG. 13. BANNER SIGNAL.

The second form of automatic track-circuit signal is illustrated in Fig. 13, and is called a "banner" signal. The information is given by two discs of different forms (one for safety and one for danger), mounted at right angles to each other on the same vertical revolving shaft. This shaft is operated through a clock-work mechanism by means of a falling weight, which is alternately caught and released by the signal magnet as it is affected by the arrival and departure of trains. In Fig. 13, the signal is represented in the danger position.

The third form, the Westinghouse electro-pneumatic block system, is the only one by which the regulation semaphore may be utilized for automatic blocking. The signal post in this method bears a compressed-air cylinder, which, when filled, carries the signal arm to

safety, and, when empty, allows a counter-weight to fall and the arm to assume the danger position. The admission of the pressure to the cylinder is regulated by the signal magnet (Fig. 11), the operations of which are dictated exactly as was described in the explanation of that figure.

Briefly, the first two forms of automatic signals cost more to install than any plain manual system, but their operation is much less expensive, if men must be employed solely for attendance on the manual block signals. Therefore, where the length of the blocks is less than the distance between stations, an automatic system will cause the least ultimate expense.

But a point has been reached on many lines where the switches in the main track are so frequent (and where interlocking cabins will eventually be required) that the controlled manual block system (the most costly of all, when the wages of signalmen are considered) is advisable now, since the men who are needed to throw the switches in an interlocking cabin may be utilized for operating the block signals.

What may be called the internal affairs of a railway have, so far, suffered little interference from the courts and the State legislatures (with the exception of the meddling with rates by the granger statesmen of the west), but there is an evident inclination in that direction, which is to be a growing factor in railway management. In physical matters this is so far limited to car coupler and air-brake regulation; some States also have laws requiring that an interlocking machine shall be provided wherever two railways cross each other at grade; but this is a broader matter than the term internal affairs is intended to cover, for the crossing involves two or more separate railways.

The protection, by signals, of one train from other trains on the same railway has not yet been required by law in the United States.

But it is coming.

How soon it will mature is largely dependent on the amount of signalling done voluntarily by the railways themselves. When the people are aroused by a succession of disasters, the railway interests will find themselves threatened by laws passed in response to a popular demand by ignorant demagogues or venal politicians, different in different States, conflicting and embarrassing to the last degree.

It is the change of view which is needed, and all that is needed; if it be spontaneous, so much the better. The question should not be: "Is there any way by which the use of signals may be avoided?" but: "Will signals accomplish the improvement sought?"

THE ERA OF EXTRAVAGANCE IN THE ELECTRICAL BUSINESS.

By Burton E. Greene.

WALKING up Fifth avenue in Pittsburg one day in 1886, Mr. George Westinghouse, Jr., said to one of his salesmen, who at that time had been connected with the electrical business for five years:

"What is the matter with this business? I've been in it now for six months, and have lost $40,000. Something is wrong. Everything we make is sold at a profit of from one hundred to two hundred per cent. above shop cost, and yet there is nothing left. On the contrary, we need more money all the time."

Mr. Westinghouse was neither the first nor the last to express this wonderment at a condition which must have seemed anomalous to a trained manufacturer. Yet there was little of the mysterious about the situation, and the wonderment is that the fundamental causes should not have been discovered and remedied much earlier than they were. But it is due to Mr. Westinghouse to say that he was the first one among the large manufacturers to find the weak spots, and to establish an electrical manufacturing business on lines very similar to those in vogue in the manufacture of locomotives or of wheelbarrows.

Close students of the commercial side of the electrical industry are strongly inclined to the belief that now, after sixteen years of expensive and misguided struggle, of fever and unrest, a new order of things is about to be established; that the business has touched rock bottom, and can now take its place among the stable and substantial industries of the country, affected certainly by general conditions, but offering to the investor as large returns as any other legitimate manufacturing business.

The unsatisfactory results of the past are historic facts. To make an intelligent prophecy of what the future has in store, it is necessary to review the conditions which have existed since 1879-80, and to determine whether or not the fundamental troubles have been to a sufficient degree eliminated. In making such review, it is imperative to bear in mind that the electrical business has no parallel in the history of the world. Its development has been like nothing else under the sun. It is unique, and can not, in justice, be compared to other lines of manufacture.

The writer recently asked the opinions of the four inventors upon

whose work the leading pioneer companies were founded as to what were the chief reasons for the failure to make money.

Mr. Brush replied, and truly, that the company which bore his name made money, and plenty of it. He did not know anything about the affairs of the others, and had no opinions to express.

That remark suggests the chief reason why the Brush Company did make money and pay handsome dividends. They paid strict attention to their own affairs, did little experimenting after a successful arc machine had been developed, handled their sales department with energy and skill, and sailed no kites.

Mr. Edison said: "I think the chief reason was insane competition. The apparent profits attracted a horde of pirates and hangers on, too lazy or too stupid to do original work, who devoted their time to stealing the work of the real inventors. Patents were no protection. Even if sustained ultimately, the heart had been cut out of the business, and they were not worth the cost of the litigation."

I recalled to Mr. Edison the years of delay in pushing to conclusion the trial of his most important patent,—that on the incandescent lamp,—and asked who was to blame for it. He replied:

"I suppose I was, more than any one else. We ought to have pushed that suit in 1882. But at that time we did not have an unlimited amount of money. We were building the New York lighting station, and I wanted to demonstrate that we could go underground. This cost a lot of money, and we could not raise enough to carry on the litigation at the same time. I thought the best plan was to show as quickly as possible that we had a complete and successful *system*, and leave the patent suits till we had made more money. This was probably a mistake. Such a decision as we finally got on the incandescent lamp would have made us supreme in the entire incandescent lighting field, if we had got it a few years earlier.

"People don't stop to think," said Mr. Edison, "of the enormous investment on which it was necessary to pay dividends in order to make the company, as you say, profitable. Why, it cost us over a million dollars to perfect the incandescent lamp, and, after we had done the work, the other fellows came in and took our profits.

"If I had invented a new wrench, I could have gone to the different manufacturers in that line, and got each of them to pay me a small royalty, which in the aggregate would have been a nice income. They would have made money also, and the profits would not have been big enough to tempt an army of adventurers to come into the same line. But the production of a system which revolutionized the lighting of the world opened an attractive field, and what ought to have been a gold mine for a few turned out to be at best only moderately profitable."

Prof. Thomson attributes the partial failure of so many of the larger companies to make money to the rapid growth of the business, compelling the continual enlargement of the investment. Even if money was made, it could not be distributed.

Mr. Edward Weston is inclined to be rather severe in his criticisms of the commercial management of the early companies, forgetting that some of the inventors on whom the commercial men had to rely often spent a great deal of money and wasted valuable time in the endeavor to perfect apparatus built on lines which have been proved to be absolutely wrong.

The faults of early management did not lie exclusively either with the technical men or with the financial management. The errors of judgment were many, and are not difficult to see—after it is all over.

Probably one of the greatest drawbacks to commercial success was patent litigation. It is known that in one year three of the leading companies spent $1,500,000 in this direction, or five per cent. on their entire capital stock. A score of law firms could be named who devoted most of their time for sixteen years to electrical patent litigation. They have waxed rich.

And beyond the severe drain on the finances of the companies caused by this campaign of litigation, there was the more serious waste of energy, which should have been expended solely in developing new ideas and extending the field of operation. Many of the most profitable and promising lines of development, such as the application of electric motors to machine practice, transmission of power, etc., were not taken up in earnest till quite recently.

How futile this continued and expensive struggle over patents has proved the world knows. One can count on the fingers of one's hands the patents which have been sustained, and on one hand those which have returned to their owners a royalty which made their winning worth the while.

It is easy to say that all this result should have been foreseen. It was *not* foreseen; and the men who were the most interested are entitled to rank in the first class of America's business men.

There is also to be taken into account the remarkably rapid development of apparatus, the almost daily introduction of new devices displacing everything else in the line by their superiority. It is not too much to say that millions have been wasted or lost in this way. It has been nothing unusual to see $500,000 worth of obsolete apparatus in some of the larger factories. This development was, perhaps, most conspicuous in the railway field. It is now less than ten years since this branch of work began to attract serious attention. Every year has produced something far superior to that of the year before. The stand-

ard apparatus of January has ofttimes become antique by December, and the stock been relegated to the scrap-heap.

In lighting apparatus the changes have been only slightly less marked. If I recollect correctly, only belted machines were sold up to 1892. Now one finds few chances to sell anything except direct-connected apparatus.

In fact, if we look over any lighting or railway system carefully, we find there is scarcely a detail which has not been through a half-dozen remodellings in ten years. A bright exception is the incandescent lamp itself, which is to-day, save in refinements of manufacture, just what it was in 1880.

Any manufacturer knows that these revolutionary changes in types mean money lost. The aggregate in sixteen years is almost beyond conception. Even in small supplies, it has been a very serious matter. Dead stock has been the cause of more than one failure, and goods bought with the best of judgment have become dead stock almost in the twinkling of an eye.

Closely allied to the subject of obsolete apparatus is that of experiment and research,—the continued striving for something better. In some of the companies the charges for this department have been from $100,000 to $300,000 per year. Could this expense have been avoided? It is not easy to see how. The company which rested on its oars would have been outstripped in the race in a few months. Indeed, those who were unable to raise money to keep up their experimental work came speedily to a disastrous end.

Another direction in which there was profligate waste and extravagance was in the high salaries paid,—salaries out of all proportion to the commercial value that the men receiving them would have enjoyed if engaged in any other trade. This was partially unavoidable, from the fact that men who knew anything of the science were scarce. For a great many years the business grew so rapidly that the competition for men of any degree of knowledge was intensely keen. Many who had never been able to earn more than a $2,500 salary elsewhere found themselves in demand at three times that figure. With the salaries the whole scale of expenses grew in proportion. The heads of the companies thought they were doing business at a handsome profit, and it was a long time before they appeared to realize that economical management was essential to turn the profits into money in bank. On the salary-lists were scores of "experts" who did no work except to assist the patent attorneys; in no sense were they producers. The prodigality with which money was spent at electrical gatherings would have led a stranger to suppose that each one present had the income of a Rockefeller. Extravagance was in the air.

The salesmen, no doubt, honestly believed that they were earning their large salaries, and that the companies were making money. A generator on which shop cost was given to them at $1,000 would be sold at $2,500 or even $3,000. Certainly this looked profitable. Where did the margin go? To start with, travelling expenses were enormous. Trips were long, and possible sales few in number. And when a plant was sold 1,000 or 2,000 miles away from the home office, there were the expenses, not only of the salesmen, but of a small corps of engineers to instal the plant and leave it in actual operation. One case occurs to me in the west where a plant was sold for $1,200, and the expense accounts of the salesmen and engineers on that job aggregated over $1,300. In many cases, of course, the expenses were incurred, and the other fellow got the job.

The chief causes for the acknowledged unsatisfactory results have been outlined. Criticism should be tempered with charity. Possibilities of development and discovery were so great that even the most conservative were dazzled. The problems of economical manufacture received scant attention. The entire energy of the executive departments was expended in exploring new fields,—booming the industry. That this was done in a masterly manner is attested by the fact that scarcely a hamlet remains in the country without an electric-light plant, by the passing of the horse-car and the all but universal adoption of the trolley.

So much for what has been. What has the near future in store? What hope is now held out to the investor by the situation as it is to-day? Has the turning-point been reached?

No one who has followed closely the events of the past four years can doubt that the revolution is well-nigh accomplished, and that the electrical industry is now ready to take rank among the most solid, conservative, and profitable in America or any other country. The lessons have been expensive, and thoroughly learned.

The patent agreement reached by the leading companies has put an effectual stop to further waste in this line. There will be a saving of hundreds of thousands a year, and the heads of the companies will have more time to devote to actual commercial work.

Continued or radical departures from present types of apparatus are no longer to be feared. Systems are to-day practically standardized. The huge multipolar direct-connected machines are the most efficient producers of power known to mechanics, and there is no likelihood of vital changes. And, if Tesla or any other genius shall produce a machine to give us electricity direct from coal, the electrical industry as a whole would be the surest and largest gainer. Of course, the ultimate of development has not yet been reached, but further pro-

gress is bound to be in the direction of perfecting present types. High-speed electric locomotives will be built. They will not displace present-day street-car equipments, for the limit of speed allowable on public thoroughfares is much below the possibilities of the apparatus of to-day, which has an efficiency of over ninety per cent.

In the lighting field there is great activity and much newspaper talk of the "New Light." The problems are not yet solved, and when they are, established manufacturing companies will be the first gainers.

Neither Edison or Tesla has yet claimed any such thing as a revolution from their work in this line.

Mr. Edison was recently asked by an enthusiastic and excitable young man: "Will you have your new lamp on sale next week?" The reply was: "It took me five years and cost a million of money to perfect the incandescent lighting system. It may take as long, or perhaps even longer, to make a commercial system on the lines in which I am now experimenting. The results so far achieved have been surprising and intensely interesting. Something practical may be discovered any day, but the apple is not ripe yet,—at least, not in my laboratory."

It is evident from the recent report of the committee of the American Institute of Electrical Engineers, which investigated and made tests of the etheric lighting system of Mr. D. McFarlan Moore, another worker in this field, that at present his system is more than four times as expensive as incandescent lighting.

Mr. Tesla is working on distinct lines, and has not yet taken the public into his confidence sufficiently to warrant any positive statements as to the results attained in the last few months. This much he has said: "I have gotten rid of my vibrator and the expensive coil which produced the effects shown in my St. Louis lecture in 1893. My apparatus is much simplified, and I shall lay the results of my advances before some scientific body the coming fall."

Tesla himself is very reticent about the newest developments in his laboratory. He has made no sensational claims, and, if he were an owner of any gas or electric-lighting company's stock, would surely hold it for a year or two more.

No *danger* to present investments need be looked for from this direction. Final announcement of the commercialization of etheric lighting will be welcomed by no one more heartily than by our large electrical manufacturing and lighting companies.

Expenses for experimental work have not been entirely eliminated. They never can or ought to be eliminated from any progressive trade depending upon invention for supremacy. But they have been reduced to less than one-tenth of the average of ten years ago.

Extravagant salaries are no longer common. They have been very generally adjusted to meet changed conditions. There is no longer a scarcity of men with a knowledge of electrics. In fact, the market is becoming overcrowded. All along the line sensible economies have been put into practice, and the expenses of doing business are nearly as low as in any of the old established industries. District managers, and district offices, which were in reality so many distinct business establishments where extravagance reigned supreme, have been abolished, without any great diminution in sales.

Comparing the present situation with any other period since 1880, there is nothing but encouragement for those engaged in electrical manufacture. They are offering for sale what the public must buy. The demand is as certain as the demand for ploughs or farm-wagons. The boom period has passed forever. The industry will no longer suffer from so many diseases peculiar to itself. It will thrive as general business thrives, and be less susceptible, perhaps, to a general depression than almost any other.

The chief danger to-day is that which threatens alike every commercial enterprise in America, from the railroads to the farmer, even to the individual laborer,—the danger of an unsettled financial policy. Of the ultimate triumph of the gold standard there can be no question. Meantime the evidence of financial heresy spreading through large sections of our country cannot be ignored.

With this question finally settled, the profitableness of the electrical trade would be beyond question.

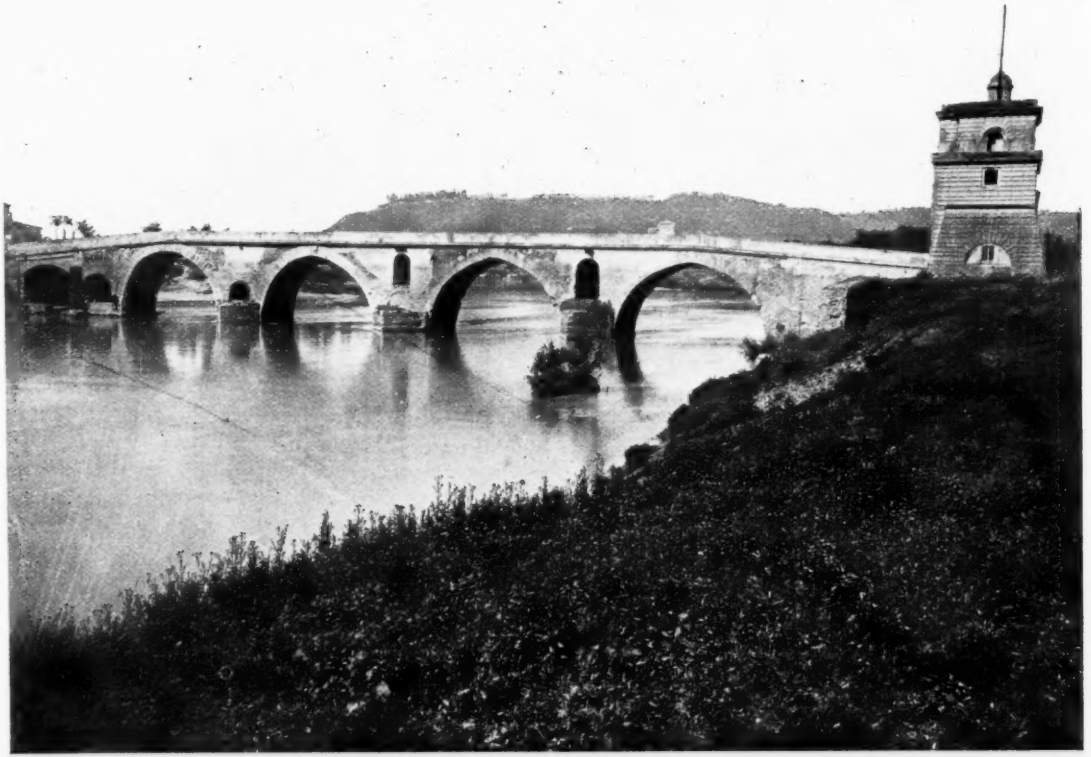
THE ARCHITECTURE OF BRIDGE-BUILDING.

By E. C. Gardner.

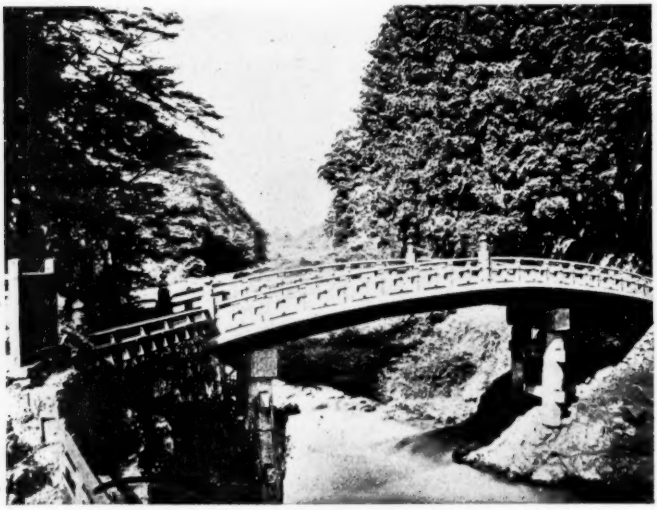
THE formal title of the man who probably exerts a greater influence in the civilized world at the present time than any other human being, the title inherited from almost a score of centuries of predecessors, is The Supreme Bridge-Builder,—Pontifex Maximus. The ancient Romans, with whom this dignified appellation originated, held bridges in so high esteem for their service to mankind that they invested them with a distinctly religious character; they were founded by religious orders and dedicated with religious ceremonies, and the important ones were in charge of priests. In later centuries they ranked among works of philanthropy and benevolence, and the names of their founders and designers were honored and preserved among the benefactors of mankind.

It is the aim of this paper, not to consider the principles of construction involved in this most indispensable of all modern engineering work, but to suggest certain considerations relating to their visible design,—to what, for convenience, might be called their architectural rather than engineering characteristics.

ANCIENT AQUEDUCT NEAR ROME.

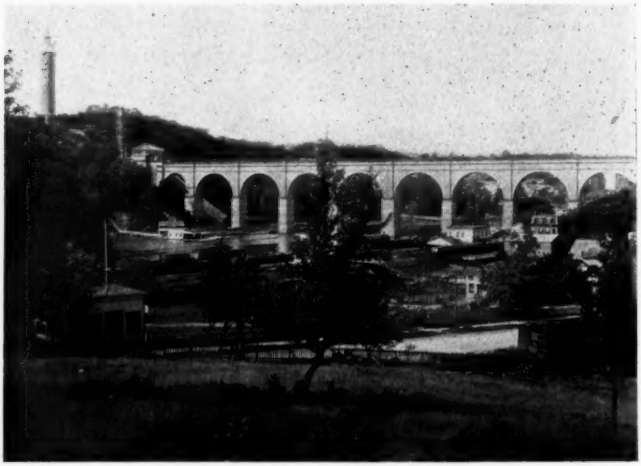


BRIDGE ON THE VIA FLAMINIA, PORTO DEL POPOLO, ROME.

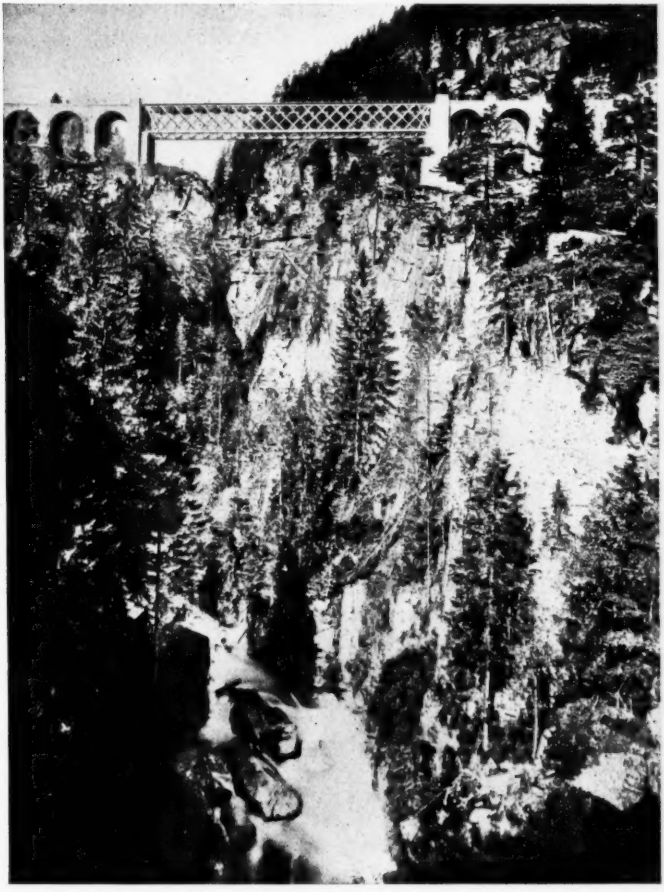


SHOGUN'S BRIDGE, JAPAN.

From the rustic pathway that carries a forest trail across a mountain brook, to the gigantic viaduct that spans an arm of the sea, bearing railway trains above the tallest masts of the steam-ships, bridges



HIGH BRIDGE, NEW YORK.



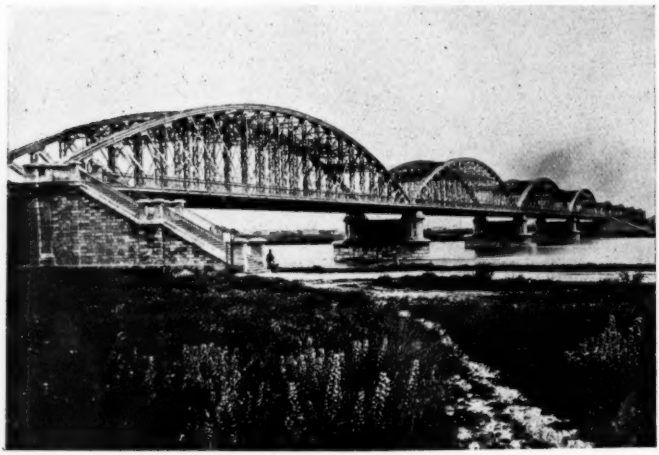
THE UPPER BRIDGE, ST. GOTHARD, SWITZERLAND.

have a natural right to be reckoned among the most interesting and beautiful of all artificial structures. Nowhere are nature and the arts of building brought into more intimate relations; nowhere does nature more generously respond to our attempts to make our work harmonize with hers.

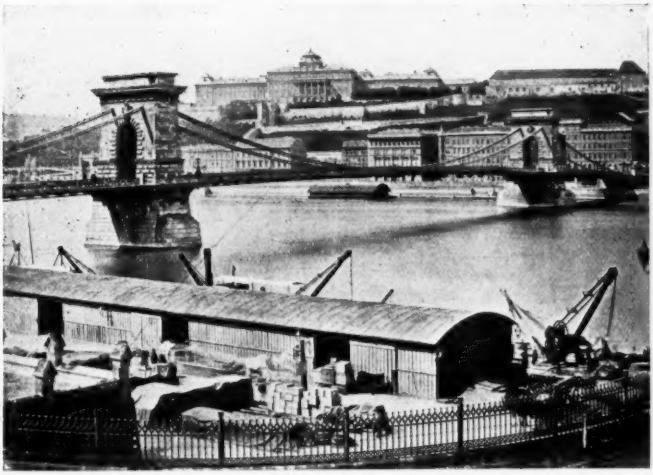
Man is a travelling animal; when the way is not open, he prepares a way for himself. If there are mountains in his track, he bores

through them ; forests he cuts down. He sails across the ocean, and bridges the gulfs and rivers. We Americans have also inherited from many generations of restless ancestors what might be called an anticipation of change,—always for the better, of course, but inevitable. We take it for granted that we shall tear down in a few years and build bigger ; that we shall move on for the sake of greater prosperity ; go west for more room to grow. But there are disadvantages in having too large a country and in being too large for our age. In the effort to meet the growing demands upon our resources, to take actual possession of our heritage, we do many things for immediate use rather than for lasting service,—with more regard for quantity than for quality, and with a sort of frivolous frailty that is sometimes the most satisfactory thing about our work. If we must have monstrosities in the way of buildings, public and private, let us be thankful that they are rarely fire-proof.

To the pioneer who does not even know that he shall ever retrace his steps, a fallen tree or a rope of twisted grass suffices to span a gulf or stream ; and, for the railroad that must at the hazard of its own life reach a distant point before some competing line has drawn travel and population in another direction, a wooden trestle that creaks and sways under its train of cars laden with foreign emigrants and other crude but valuable ore is all we have time or money to provide. We cannot stand upon the order of our going, but must go at once. Undoubtedly this spirit of enterprise, to call it by its best name, accounts



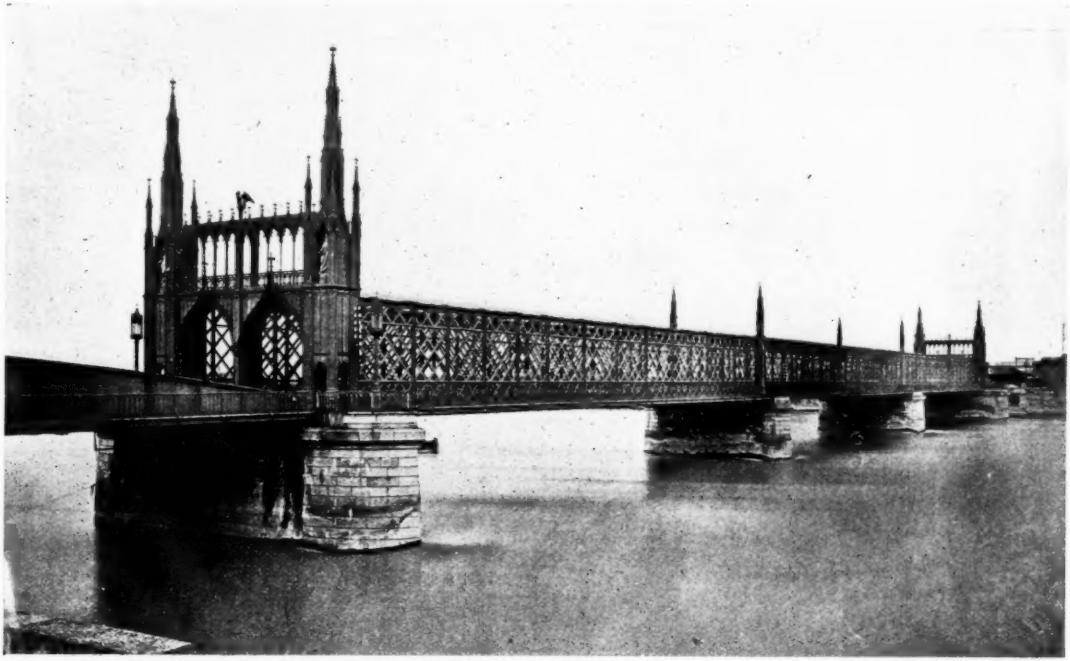
BRIDGE AT VIENNA.



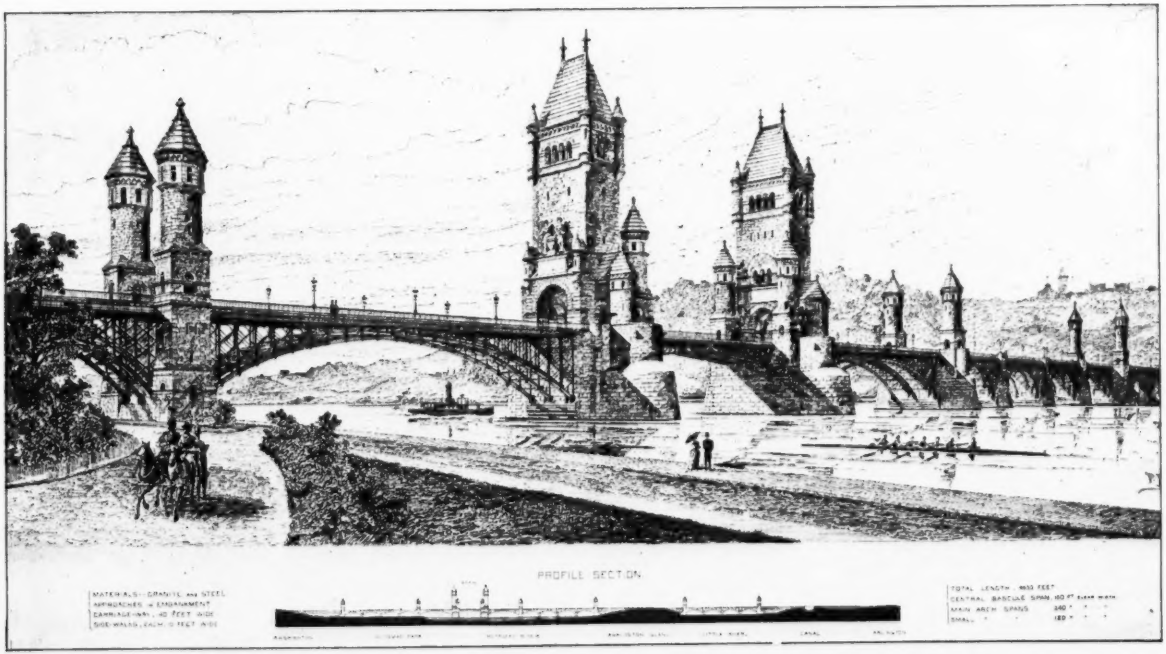
SUSPENSION BRIDGE AT VIENNA.

for much of our cheap and unsatisfactory work in many directions.

But we are growing older and wiser; we are learning that it pays to be thorough; we are beginning to understand that, the more permanent our work, the more imperative is the obligation that it should bear visible evidence of the trained skill and earnest thought by which alone the lasting quality of artistic excellence is achieved. Broadly speaking, it is true that whatever is made on the lines of strict economy and utility will be beautiful. If the contrary appears to be the case, it is time to question the correctness of our ideas of beauty and the soundness of the principles on which our economy and utility are supposed to be based. To an educated mechanic there is great beauty in a steel truss in which perfect compliance with mathematical law is apparent, and equally conspicuous ugliness when these principles are violated. But he would be a dogmatic engineer who should say that there is but one right way in which the materials that form the girders of a steel bridge can be disposed. He would be an incompetent engineer who should say that, in choosing between the forms that lie strictly within the lines of utility and economy, beauty may not also be sought and found. Suspension bridges cannot easily avoid being beautiful in the lines of their essential construction, but, aside from these, the distinctly artistic element of steel bridges, speaking in paradox, is to be sought in their supports and approaches,—that is, in the masonry of the piers and abutments on which they rest. These,



BRIDGE AT STRASBURG.



PROPOSED GRANT MEMORIAL BRIDGE ACROSS THE POTOMAC AT WASHINGTON. SMITHMEYER & PELZ, ARCHITECTS.

which must first have strength and durability, also afford ample opportunity for grace and elegance of form, and, in large structures, for dignity and grandeur of proportion; while, in conspicuous places, richness of material and a high degree of decoration are as appropriate and desirable as in any other public or private building.

It is one of the striking incongruities in the work of our great railway corporations that they will spend lavishly upon the exteriors of their stations in large cities,—stations often located on subordinate streets,—while over main avenues or popular thoroughfares the viaduct, which might be a perpetual object-lesson of beautiful architectural design, of scientific construction, and, if they please to consider it from that point of view, a perennial advertisement of the wisdom and taste of the corporation,—this viaduct is made with the apparent indifference to external appearance that might characterize the scaffoldings or derricks temporarily erected for the destruction of a disused store-house. The façades of the business blocks that border the street are by no means as conspicuous as the structure that carries the trains across it, for this of necessity is visible,—often obtrusively and obstructively so for a long distance in either direction. Indeed, it is beyond argument that a permanent structure in such a position should possess the highest degree of architectural beauty; otherwise it is an impertinence and a gross violation of the unwritten law that enjoins

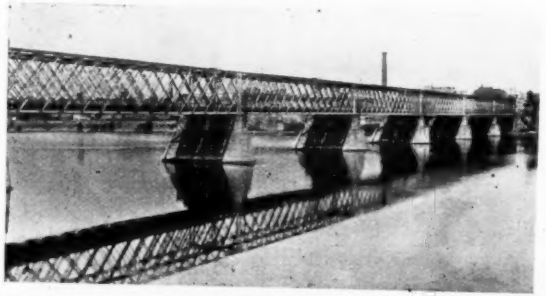
BOSTON AND ALBANY RAILROAD BRIDGE, SPRINGFIELD, MASS.

BRIDGE OVER THE PO, TURIN, ITALY.

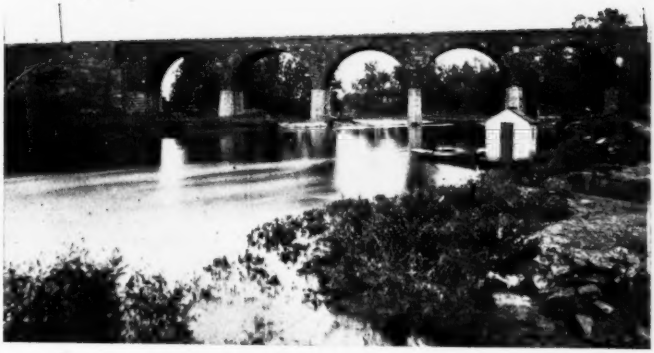
corporations to treat the public with at least an outward show of respect.

Of railroad bridges in the open country it needs to be said only that there should be enough of them to prevent grade crossings of highways. But, when they are actually within towns or cities, or so near them that they are likely to be surrounded by the cities' growth, their appearance should correspond, not with their present surroundings, which may be in a transition state, but rather with their probable environment in the future. For, of all substantial structures, bridges are the most immovable. Churches are torn down to make way for commerce; schools change with changing methods of education; one kind of business crowds out another; even prisons and poor-houses are passed along by the surges of population; but the great thoroughfares of travel, once established, are inflexibly conservative, and all that is visible in their construction should possess the qualities that entitle them to respect and admiration.

The new State highways which, happily, are beginning to crawl across the country, binding it more firmly together and giving added strength to its institutions, should be models of thoroughness. This, for most, if not for all, minor streams, means bridges of masonry; for the wider spans, a combination of masonry and steel. Arches of brick



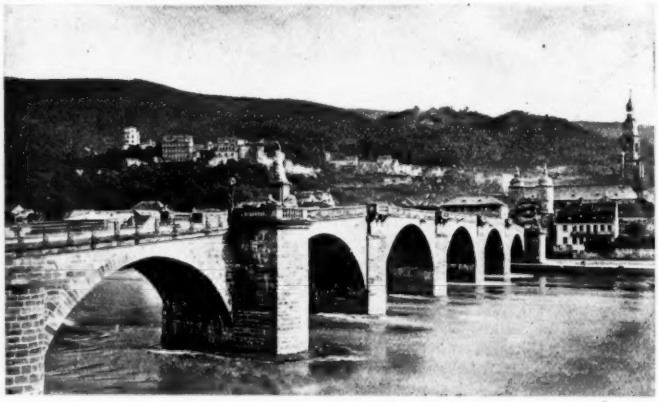
SOME BRIDGES OF THE BOSTON AND ALBANY RAILROAD.



BIG CONESTOGA CREEK BRIDGE.

ON THE LITTLE CONEMAUGH RIVER.

TWO BRIDGES ON THE PENNSYLVANIA RAILROAD.



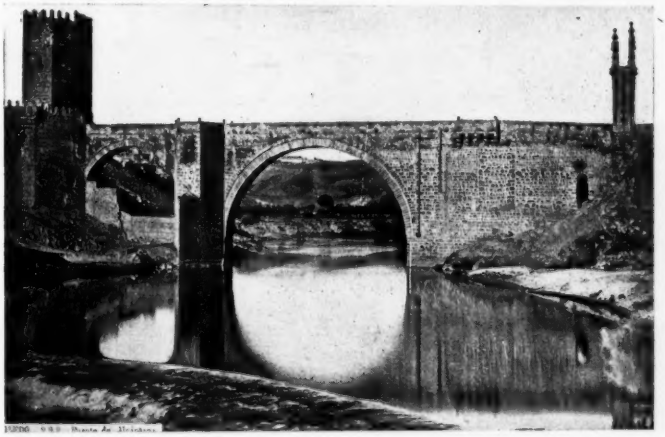
BRIDGE AT HEIDELBERG, GERMANY.

and stone are by no means as difficult of attainment as is commonly supposed. Undoubtedly iron and steel are handled with far greater skill and economy than they were a few years ago, but the use of stone, bricks, cement, and other forms of artificial masonry has been modified and improved in scarcely less degree, and it is true in many cases

BRIDGE AT PISA, ITALY.

that a skilfully-constructed arch would cost but little, if any, more than the necessary buttresses for the support of an iron or wooden girder. It is certain that the rivers will never cease to run,—certainly not this side of the Rocky mountains. It is almost equally certain that the stream of human travel will follow the same lines that are now established, as long as our civilization endures, and there is no excuse for temporizing in the building of its channel.

There is no artificial structure that more readily admits of a satisfactory combination of the practical with the sentimental, using the latter word in its legitimate sense,—that is, as the visible expression of a worthy sentiment. We have memorial churches, halls, towers, and fountains, but from the permanence and constancy of their service,



BRIDGE AT ALCANTARA, SPAIN.

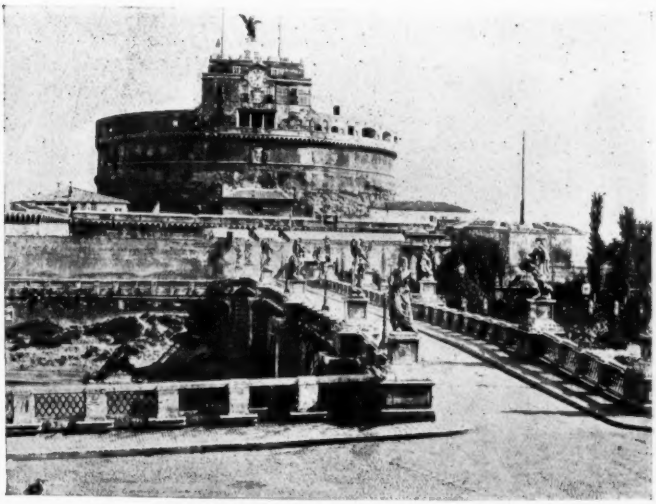
from the instinctive and traditional gratitude that leads us to "speak well of the bridge that carries us safely across," from the sense of triumph over a stubborn obstacle, and from the religious sentiment that is associated with the grandest achievements of this kind both in ancient times and in the middle ages, there is a peculiar appropriateness in giving a memorial or monumental character to these structures, whether they carry railway trains or bicycles, and whether they cross rivers, streets, or rocky ravines. It is easily possible here to maintain the visible distinction between the utilitarian and the monumental, the lack of which distinction is so often fatal in the attempts to combine the two in one structure. Towers for military defence of the approach to a city or province, which gave such beauty and dignity to

many of the bridges of the middle ages, are obviously useless at the present time, when an electric torpedo would hurl the most massive arches into piles of worthless rubble, when long-range cannons laugh at any river, however wide and deep, and when balloons laden with dynamite ride with fearful menace along the viewless highways of the air; but, if we cannot adorn our bridges with crenelated watch towers to repel invading foes, we can attach to them facilities for rest and recreation, and perhaps in some degree hasten the time when there will be no fear of hostile invasion.

In our abundance of land, few American cities would care to

THE OLD BRIDGE, TORCELLO, ITALY.

convert even the most central bridges that cross the rivers, providentially passing beside or through great cities, into mere extensions of the ordinary street, as was so often done in the compact, walled cities of medieval Europe. For more than three centuries the Ponte Vecchio in Florence has been bordered with jewellers' shops; the old London bridge, if the pictures tell the truth, might have been a double row of tenement-houses; and the description of the wooden bridge of Notre Dame, built in 1433, assures us that, while crossing it, one could not see the river, and, from the number and variety of the goods displayed in the shops, one would never doubt that he was on dry land. There is, in fact, ample precedent for any conceivable use for a bridge in



BRIDGE AND TOWER OF SAN ANGELO, ROME,

addition to its one essential function. Chapels were among the most common accessories, and the statues of saints and heroes along the parapets are quite in order. Shops for all kinds of merchandise,—

THE PONTE VECCHIO, FLORENCE, ITALY.

THE RIALTO, VENICE.

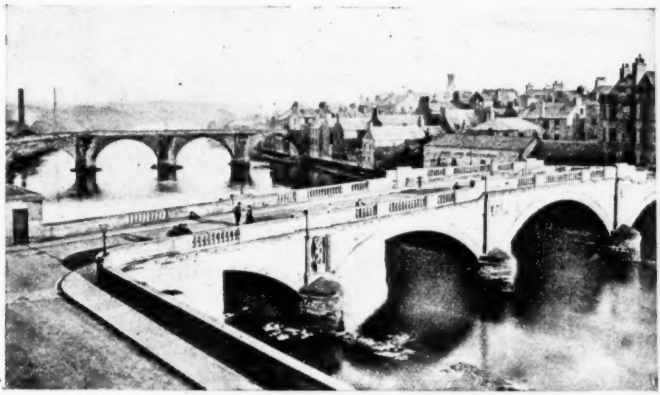
from fancy dry goods to live stock,—mills, factories, banks, schools, and prisons have rested upon the same piers that carried the bridges.

What would be far more suitable for our time and taste would be to make these urban bridges take the place of the public squares with

BRIDGE AT THE LAKES OF KILLARNEY, IRELAND.

THE BRIDGE, LEAMINGTON, ENGLAND.

which most of our cities are so scantily supplied. If our river-banks were always treated like the banks of the Arno and portions of the Seine and the Thames, there would be less need of using bridges for anything but travel. Unfortunately our river-banks are usually given over to commerce; or, worse, they are adorned with sewer outlets and factory tenements, and make a dumping-ground for garbage. But, by building the bridges that carry the streets across the river wider than the mere passing of travel requires, we have at once the most



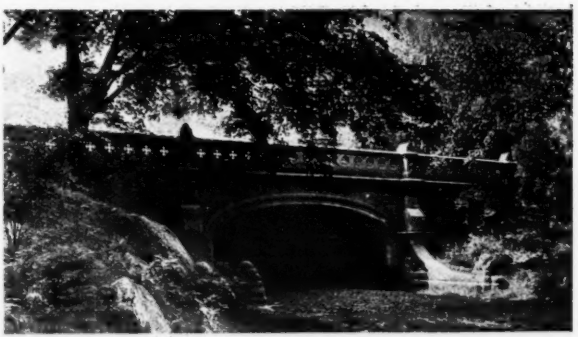
THE "TWA BRIGS O'AYR."

A WEST-SIDE ENTRANCE, CENTRAL PARK, NEW YORK.

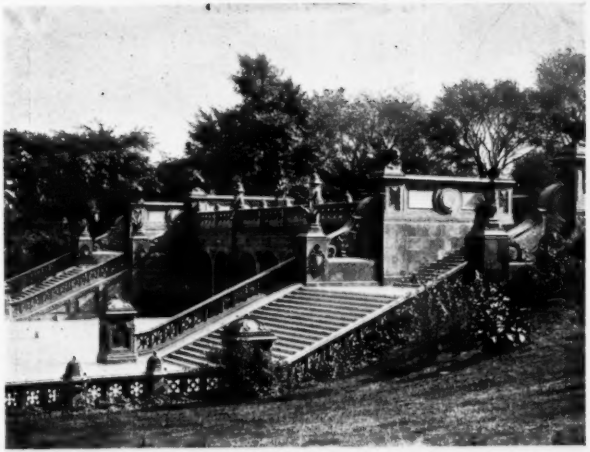
IN GOLDEN GATE PARK, SAN FRANCISCO.

attractive public park and promenade possible. It is strange that the universal instinct to loiter on the bridge and watch the water beneath, with its celestial reflection from above and the landscape up and down the river, beautiful in its perspective however crude it may be in its near detail, has not led to a more frequent and comprehensive utilization of its possibilities for what may be called public-square purposes. Even where parks and squares are abundant, the open river is sure to be a favorite rival of green trees and verdant turf. But there is no reason why bridges of masonry, or even of steel, should not also have green turf and flowers and fountains at each side of the roadway,—more than that, pleasant resting-places and booths for refreshments. Why not, as well as in the parks and along the streets?

RIFTSTONE ARCH.



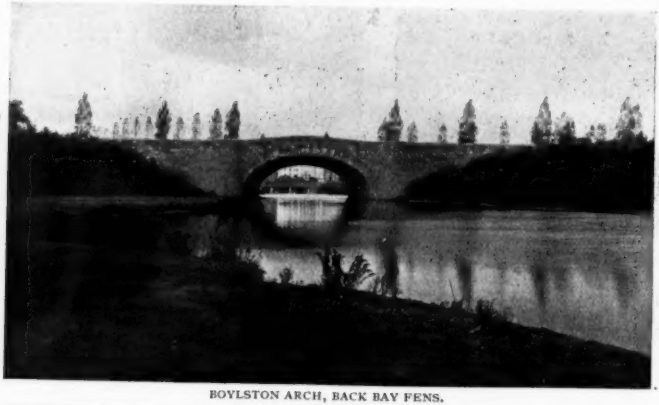
DALEHEAD ARCH.



THE TERRACE.

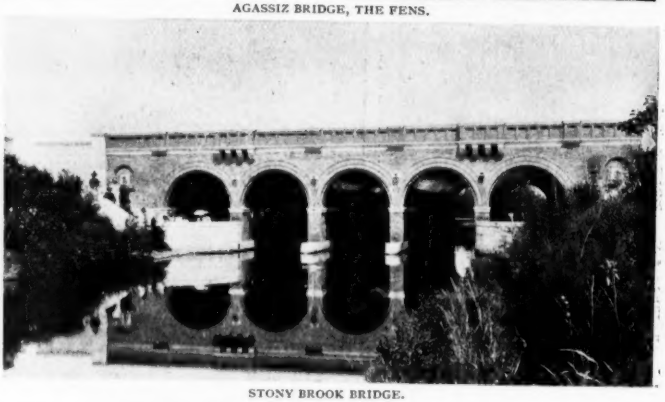
THE MARBLE ARCH.

A GROUP OF BRIDGES, CENTRAL PARK, NEW YORK.



BOYLSTON ARCH, BACK BAY FENS.

AGASSIZ BRIDGE, THE FENS.



STONY BROOK BRIDGE.

And why not even more than that? With floor and walls already provided, it only needs a permanent roof to convert a wide steel bridge into an enclosed gallery, like an arcaded street, in which the rents from the stalls along the sides would make the building of the entire structure a profitable financial investment. What virtually increases the practical economy of such additions to the superstructure is the fact that the main strength of the piers and abutments for a steel bridge is required to resist the force of the water, and the load imposed upon them is a matter of comparative indifference. Often, indeed, the heavier the load, the more secure is the bridge.

Concerning the masonry of bridges it is hardly necessary to suggest that heavy blocks of stone may be expected to resist the force of floating ice, logs, and other drift material that may be sent against them by the current better than anything smaller, but above this danger there is nothing more suitable for the structure than bricks. When it is remembered that, next to glass, burned clay is the most enduring of all mineral building materials, it is a singular conservatism that confines the use of bricks mainly to culverts, drains, and other underground construction. With the excellent building cements which are becoming more and more available,—apparently destined to rival those of antiquity, which are the wonder and admiration of modern times,—there is no limit to the availability of bricks in bridge-building, whether considered from the economical, the durable, or the esthetic point of view.

Where the span is too great, or other conditions make an arch or a series of arches impracticable, the first impulse would be to say that wooden trusses are at best wasteful,—a temporary economy resulting in ultimate loss. Still, we need not forget that from the time of Julius Cæsar until a comparatively recent date the most famous and serviceable bridges in the world were of wood. There were none but wooden bridges in Paris until within two or three hundred years, and there is no apparent reason why a well-planned wooden bridge should not enjoy a useful life as long at least as that traditionally allotted to the crow. This would call for the same protection from the action of the weather and the ground as would be given, as a matter of course, to any other wooden building resting on stone or brick foundations. Other things being equal, there is evidently more scope for architectural effect, both of composition and ornamentation, in a wooden structure than in one of iron. Here is another conspicuous inconsistency in the expenditure of public funds: it seems to be accepted as an axiom that, for the building of a bridge, nothing shall be allowed beyond actual necessities for the bare utilitarian needs; while a public building that may be seen less, used less, and be really of far less

value to the community is often given a large percentage of its cost for purely esthetic ends.

The many beautiful bridges in our public parks, whether of wood, iron, or masonry, are admirable examples of what may be done by making these features of utility also objects of grace and beauty,—whether they are intended primarily to carry us safely over a chasm, or to create a pleasing detail in the landscape.

It may seem unreasonable to ask for a high degree of artistic excellence in the design of a bridge over a mill stream or a railway track, but the simple truth is that there will be no social or industrial salvation for us until we have learned to apply the best scientific knowledge and artistic training to everything we build, from barn doors and brick culverts to "marble domes and gilded spires." Our work must not only serve our necessities, but minister to our enjoyment; it must add something more than mere convenience to the value of life. And the more extensive it is, the more commonly used, and the more permanent its character, the more imperative is the obligation to give it the highest possible artistic quality.

ARE THE CYANID PATENTS INVALID?

By J. S. C. Wells.

THE use of potassium cyanid for extracting gold from ores and tailings is extending so rapidly that the validity of the Mac-Arthur-Forrest patents covering the use of that solvent has become a question of much importance. Claims are already made that about one-third of all the current production of gold in South Africa is obtained by cyaniding, while, judging from recent progress in those gold fields and in the United States, it is quite possible that this method of extraction may soon be adopted in even larger proportion. Consequently the royalties now being paid and to be paid during the life of the original patents not only represent a large absolute sum, but are a serious tax upon the producer, if the process is adopted, or a restriction upon production where royalties would preclude profit to the owners of ore.

In order to obtain a valid patent, the patentee must be able to prove originality in his invention. Let us see if those in question fulfil this condition. To answer this intelligently, we must determine what was known as to the action of solutions of cyanids on gold prior to the dates of these patents.

One of the first investigators was Prince Pierre Bagration, who, when making certain experiments in 1844, used a gold-lined dish to hold a solution of potassium cyanid, and found that the solution dissolved the gold lining. This observation led him to further investigate the subject, and he found that gold precipitated from a solution of the chlorid by ferrous sulphate was also soluble in the cyanid.

In 1846 Elsner confirmed Bagration's observations, and proposed the equation which is now generally accepted as representing the action taking place when gold dissolves in cyanid,—*viz.*,

$$4\,Au + 8\,K\,Cy + O_2 + 2\,H_2O = 4\,K\,Au\,Cy_2 + 4\,K\,O\,H.$$

Numerous other authorities might be cited, all speaking of the solubility of gold in cyanid as a well-known fact. Gore, in his work on electro-metallurgy, makes the following statement: "If too much free cyanid is used in the gilding solution, the anode (gold) is dissolved whilst the current is not passing."

Faraday, in 1857, made practical use of the solvent power of cyanid for gold by using it to reduce the thickness of gold leaf which he was preparing for his researches on light (*Phil. Trans.*, 1857, p. 147). That air or oxygen was necessary to the reaction was also

known to him, as is shown by the following quotation: "When one piece of gold leaf was placed on the surface of a solution of potassium cyanid, and another, moistened on both sides, was placed under the surface, both dissolved, but 12 minutes sufficed for the solution of the first, whilst above 12 hours were required for the submerged piece. In weaker solutions, and with silver also, the same results were obtained, from sixty to one hundred fold as much time being required for the disappearance of the submerged piece as for that which, floating, was in contact both with air and the solvent." He also tried gold precipitated in various ways, and found all soluble in cyanid.

W. Skey, in a paper on "The Electro-motive Order of Certain Metals in Potassium Cyanid" (*Jour. Chem. Soc.*, vol. 30, p. 588, 1876), makes a very important statement. Its bearing on the cyanid process is so direct that I quote it entire: "It must further be remembered that gold and silver are not quite insoluble in cyanid. The loss of metal which falls upon the mercury, gold, or silver of these blanketings (concentrates) depends, therefore, entirely upon the relative affinity of these metals for this salt. Now, it is distinctly affirmed that neither gold, silver, nor platinum directly precipitates mercury from its solution, but, on investigating this subject, the author found that in reality mercury is not positive, but very decidedly negative, to gold or silver in potassium cyanid,—gold and silver being dissolved in mercuric cyanid, while mercury precipitates. The following is a list worked out by the author, showing the electro-motive order in potassium cyanid of various metals occurring in gold fields or being employed for milling gold. It runs from negative downwards to positive: C, Pt, Fe, As, Sb, Hg, Pb, Au, Ag, Sn, Cu, Zn. All other ores occurring in nature are mostly negative to the whole series. Thus it is shown that, whenever potassium cyanid is used to assist in the amalgamation of blanketings, the loss falls upon the gold and silver present, the mercury being positively protected from the action of this salt by these more valuable metals."

The above quotation covers all the principles of the cyanid process. We have the solution of the gold and silver in the weak cyanid, and, as shown by the list, the fact that they are precipitated from such solutions by zinc. It is evident, then, that the solvent power of cyanid for gold and silver was known long before the MacArthur-Forrest patents were granted; consequently they have no claim to novelty or invention in that respect. Their use of it as a solvent for the gold in an ore does not alter the case in the least; the gold is there present in the metallic form, and the reaction is precisely the same. Even limiting its use in this way, they have no new discovery, for Skey, as shown in the previous quotation, speaks of the solvent action of

cyanid on the gold contained in an ore, and Dr. Henry Wurtz, in a paper on "Magnetic Amalgams" (*American Journal of Science*, Vol. XLI, 1886), makes the following statement: "When gold has been obtained in solution, *either from ores* or from other materials, by the action of chlorine, aqua regia, *potassium cyanid*, or any other solvent; also, when silver has been obtained in solution in hyposulphite or otherwise," etc., then the precipitation of the metals from such solutions is more rapid and thorough, if the solutions are dilute."

It is evident from this that he was familiar with the fact that potassium cyanid would dissolve gold from its ores, and also that it was advantageous to use dilute solutions.

Cyanid was used in 1867 by Rae for dissolving gold from its ores. True, it was in conjunction with an electric current, but, as every chemist knows, the reaction would be practically the same. The electric current, if it took any part whatever in the solution of the gold, simply decomposed the potassium cyanid into cyanogen and potassium, the latter decomposing water and forming potassium hydrate. The cyanogen set free would then be ready to combine with any gold that was within reach and form aurous cyanid, this combining with more potassium cyanid to form potassium aurous cyanid. The reaction would then be:

$$Au + K\,Cy + Cy = K\,Au\,Cy_2$$

practically the same as when potassium cyanid alone was used, cyanogen being the solvent in both cases.

Rae's patent clearly covers the claim made in the MacArthur-Forrest patent for "a cyanogen-yielding substance," potassium cyanid, when acted on by the electric current, certainly yielding cyanogen. By his process, however, a large part of the gold must be dissolved according to Elsner's equation, without the aid of electricity. His method covers, therefore, the use of "a cyanogen-yielding substance," and of potassium cyanid alone; so it is hard to see what is left for Messrs. MacArthur and Forrest to base a patent on.

Simpson also antedated them in the use of cyanid on ore, his addition of a little ammonium carbonate and common salt having no effect on the results obtained other than the action of the carbonate as a neutralizing agent in the case of an acid ore.

So, in fact, we see that the idea is not new in any sense. That it was well known long before 1887 that cyanid would dissolve gold is clearly proved, and that it would also dissolve gold when contained in an ore was not new, as it had already been used for that purpose. It

seems hardly possible, then, that any claim to novelty in the use of cyanid as a solvent would be upheld in any court.

In their American patent they try to avoid this difficulty by claiming only the use of solutions containing 2 per cent. or less of potassium cyanid, and further claiming for these dilute solutions a so-called selective action, meaning by this that such a solution will dissolve the gold in preference to the base metals. They say that, if a strong solution is used, the base metals will be dissolved in place of the gold. This, as shown by Skey's researches, is not true, with the exception of copper and zinc. That these two metals will dissolve before gold, even in very dilute solutions, is well known to any one familiar with cyaniding. The presence of copper minerals in any quantity is fatal to the success of the process, owing to the selective action of the cyanid on the copper in preference to the gold. An example of this may perhaps be interesting. A lot of tailings containing some copper (as sulphid) was sent to me to be tested with cyanid. They were mixed with lime at the rate of 10 lbs. per ton,—more than sufficient to neutralize the ore,—and then treated with a 0.5 per cent. solution of potassium cyanid, at the rate of 1½ tons of solution to 1 of ore, for 58 hours. The result was an extraction of 50 per cent. of the gold and 35.5 per cent. of silver, and a loss of 10.6 lbs. (64 per cent.) of cyanid per ton of tailings.

Another test was made, using a solution containing only 0.25 per cent. of cyanid (1 ton of solution to 1 ton of ore), and reducing the time to 25 hours. In this case the extraction of gold was 20 per cent. and that of silver was 20 per cent., and the loss of cyanid was 4 lbs. (80 per cent.) per ton.

The original tailings contained 0.5 oz. of gold per ton; to convert this into potassium aurous cyanid would require 0.33 oz. of potassium cyanid. Hence, in the first test one thousand times the quantity of cyanid used in combining with the gold was lost by its combinations with other substances. In the second the proportion was nearly the same, the loss of cyanid being nine hundred and seventy times as much as that entering into combination with the gold. Truly, this is selective action with a vengeance, but hardly in favor of the gold.

Ores containing decomposing iron pyrites cannot be treated directly by cyanid, no matter how dilute the solution may be, as the cyanid would at once combine with the iron salts present. In some cases previous treatment with alkali will overcome the difficulty. Iron or copper pyrites are of such frequent occurrence in gold ores that ores containing one or both will form a large proportion of the material offered for treatment. If they have been at all weathered, they will contain decomposition products that must be removed or neutra-

lized before successful treatment is possible. As for lead compounds which sometimes occur, it was well known years ago that the sulphid, sulphate, and carbonate were all insoluble in potassium cyanid. So also with zinc sulphid and carbonate of lime, and other metallic combinations.

It is plain, therefore, that the claim of the patentees narrows itself down to this: if you treat an ore that contains nothing soluble in cyanid except gold and silver, or one from which all other soluble substances have been removed, then the cyanid will dissolve the gold in preference to the remaining well-known insoluble compounds. A wonderful discovery, surely, on which to base a patent!

What seems to me another vital defect in the American patent is the claim there made for cyanid as the solvent "without the use of any other active chemical agent." Cyanid under such conditions is not a solvent for gold, as has been shown by many experiments. Faraday, as already stated, was aware of this fact; Elsner also knew it, and states that oxygen is necessary; and McLaurin, in his very exhaustive research, has proved beyond question that, unless oxygen is present, the gold will not dissolve. He has further shown that the reason a weak solution of cyanid is a better solvent for gold than a strong one is found in the fact that the former contains more dissolved oxygen than the latter. It is also proved by his experiments that the solvent power of cyanid for gold increases as the strength of the solution increases, until the point is reached at which it contains its maximum quantity of oxygen, and from this it decreases as the amount of dissolved oxygen diminishes. The reason, then, why a dilute solution (*i. e.*, down to 0.25 per cent.) is a better solvent than a strong one is found in the fact that the point of maximum solubility of oxygen occurs in a solution containing 0.25 per cent. of potassium cyanid. If we could introduce a greater proportion of oxygen into a strong solution, it would no doubt be a better solvent than the weak one. My own experiments also prove the necessity of oxygen, and further show that, the more oxygen present, the more rapid is the action. In the following table are given the results obtained in a series of four tests. The pieces of gold used were all taken from a large gold cornet. The strength of the different solutions was as follows: potassium cyanid, 1 per cent.; potassium ferricyanid, 5 per cent.; sodium dioxid, 2 per cent.; hydrogen dioxid, 2 per cent. The solution used in test No. 1 was boiled for half an hour to expel air, the piece of gold then added, and the flask tightly corked.

It will be seen from the table that, when the air was expelled, the solution of the gold was practically *nil*, but, as the amount of oxygen increased, so did the solubility of the gold.

*Solvent.	Weight of gold before treatment.	Weight of gold after treatment.	Per cent. dissolved.	Time.
1. 100cc boiled K Cy	0.1249 grms.	0.1245	0.3	3 hrs.
2. 10cc K Cy	0.0654 "	0.0606	7.3	"
3. 10cc K Cy + 2cc Na_2O_2	0.0885 "	0.0636	28.1	"
4. 10cc K Cy + 2cc H_2O_2	0.1074 "	0.0783	27.1	"

MacArthur, in a paper read before the Society of Chemical Industry, claims that oxygen is not necessary for the reaction, at least not for ores, stating that he had made experiments on them and found no difference in the results, whether air was present or not. What method he used to prevent access of air he does not say.

To test the truth of this statement, I took a quantity of tailings, mixed them very thoroughly, took out a sample for assay, and divided the remainder into three equal portions, which were then placed in glass cylinders provided with filters, and treated as follows:

No. 1. The cylinder containing this sample was fitted with perforated rubber corks at both top and bottom, one hole in the lower one, and two in the upper, and short pieces of glass tubing were passed through the openings. Two flasks were then filled, one with a 1 per cent. solution of potassium cyanid, and the other with distilled water. Both flasks had doubly perforated corks, through which glass tubes were passed, one tube in each, reaching to the bottom. The solutions were then boiled for half an hour, and at the expiration of that time the loss by evaporation was made good by the addition of sufficient boiling solution of the same kind to completely fill the flasks, and cause them to overflow through the outlet tubes. The latter tubes were then clamped, and the flasks inverted and placed at a higher level than the cylinder. The one containing the boiling water was then connected with the bottom of the ore cylinder, and the hot water allowed to rise slowly through the contents until it overflowed through the tubes at the top, thus driving the air before it and out of the cylinder. The tubes, while still full of hot water, were closed by short pieces of rubber tubing and clamps. The flow of water being shut off, the flask was disconnected from the bottom of the cylinder and connected with one of the upper tubes. The flask of cyanid was next connected with the other upper tube, and the solution allowed to run through until it had displaced the water, and the filtrate showed

* These experiments would indicate that an aëration of the cyanid solution, either by allowing it to fall into the sump in the form of a spray or shower, or by forcing air through it, might perhaps be advantageous, when working on a large scale.

a strength of 0.5 per cent. of cyanid. The flow of solution was then stopped, all the tubes closed, and the test allowed to stand for 24 hours. At the expiration of this time water from the flask was allowed to flow in and displace the cyanid, and the washing continued until the wash water showed only a trace of cyanid. The filtrate from this test was reserved for use in No. 3. The leached residue was dried and assayed, and found to contain $7.23 in gold per ton,—an extraction of 23.8 per cent. The original tailings assayed $9.51 in gold. The result in this case would doubtless have been even more conclusive, if it had been possible to totally exclude the air.

No. 2. For this test the cyanid remaining in the flask from test No. 1 was thoroughly shaken so as to aërate it, and then added to the tailings in sufficient quantity to cover them, and allowed to digest for 24 hours. At the end of this time it was run off, and the residue washed with water, until it showed but a trace of cyanid. On assaying the residue, it was found to contain $3.31 in gold per ton,—an extraction of 65.18 per cent.

No. 3. In this case the filtrate from No. 1, largely diluted with the wash water as it was, was well shaken to aërate it, and then the third sample of tailings leached with it, in exactly the same manner as in No. 2. The residue, on being assayed, gave $4.55 in gold per ton, equal to 52.1 per cent. extraction,—a fairly good result, considering the weakness of the solution and the comparatively short time it was in contact with the ore.

No one, I am sure, not even Mr. MacArthur, will deny that oxygen is a chemically active agent, and we see from all the experiments given that it is absolutely essential to the success of the process,—not in infinitesimal quantity either, for, calculating from the equation given, we find it to be equal to 6.14 per cent. of the cyanid.

To sum up, we see, first, that there is no novelty in the use of cyanid as a solvent for gold; secondly, that the claim for selective action is not true; and, lastly, that cyanid without any other chemically active agent is not a solvent for gold. The patentees, therefore, have no claim that will stand examination, and surely no valid patent can stand on such a foundation.

That zinc would precipitate gold from its solutions was known many years before Messrs. MacArthur and Forrest took out any patent for its use in that way. It was so used to regain the gold from old plating solutions, by first acidifying them with hydrochloric acid, and then boiling. This precipitated a certain amount of the gold, leaving a considerable quantity still in solution as cyanid. Zinc filings were next added to the solution, completely precipitating the remaining gold (*Chem. News*, Vol. 8, p. 31).

An objection may be made to this on the ground that the solution here spoken of is an acid one, and therefore not comparable with the precipitation from a solution of potassium cyanid. At first glance this might seem true, but we must remember that hydrochloric acid does not decompose aurous cyanid, so the reaction in this case would be between aurous cyanid and zinc, thus:

$$2\ Au\ Cy + Zn = 2\ Au + Zn\ Cy_2.$$

The zinc cyanid would be at once destroyed by the acid present, forming zinc chlorid and hydrocyanic acid.

The above reaction is similar to that taking place in the zinc boxes, for there the gold is precipitated from the solution according to the following:

$$2\ K\ Au\ Cy_2 + Zn = 2\ Au + Zn\ Cy_2 + 2\ K\ Cy.$$

It will be seen from this equation that the potassium cyanid undergoes no change, its combination with the aurous cyanid simply being broken up, and the gold of the latter then precipitated, as shown in the first equation.

That zinc was a precipitant of gold from solutions of potassium cyanid was also known. Skey found it to be electro-positive to gold in such solutions, and consequently a precipitant for it. Price, in England, has also taken out a patent for zinc as a precipitating agent for gold (No. 5125–1884). The mere fact of using zinc in a filiform condition should certainly not be sufficient to make the patent valid. The object in using it in this state is to expose as much surface as possible to the action of the solution. The same result is accomplished by the use of zinc filings, which had previously been used for this purpose.

It would seem, then, that both in the patent for the use of cyanid as a solvent for gold, and in the one covering the use of zinc to precipitate it, the patentees are claiming as their own, discoveries that were public property long prior to their patents.

THE NATURAL WEALTH AND INDUSTRIAL POSSIBILITIES OF CUBA.

By Raimundo Cabrera.

SHOULD Cuba in the near future succeed in solving the formidable political and economical problem which she is now facing, and be successful, as well, in establishing in absolute peace a system of home rule which will permit her to develop without hindrance her inexhaustible natural resources; should she inspire confidence in capitalists and encourage the noble ambitions of the workingman,—she would certainly, in a short time, be as prosperous as California or Australia is to-day, and would, like them, attract the admiration of the world because of her wonderful development.

Cuba has in her fertile soil all the natural conditions required to attract immigration, to awaken the spirit of enterprise, and to reimburse with great profits the money which may be invested in agricultural, industrial, and mining enterprises.

Suffice it to say that four-fifths of her extensive and fertile territory, whose area is a little less than that of the State of New York, is as yet in a virgin state; the axe of the woodman has not disturbed its primeval forests, nor the drill of the miner perforated its mountains. The cultivated area after four hundred years of Spanish colonization is only about 1,046,115 hectares, while there are 12,827,206 hectares yet uncultivated and 9,248,660 hectares of virgin mountains.

Experience has shown that the fertility of these lands is simply incalculable. Should Cuba, which, owing to different and heretofore insurmountable causes, has a population of only 1,631,687,—in the proportion of 133 to each square kilometer,—freely open her many sea-ports and invite Anglo-American and European immigrants, the lands at present unproductive, one-eighth of which lie idle in the hands of the government, would yield abundant food and offer a prosperous future to a population of 9,000,000 in the 118,043 square kilometers which the island contains.

It is not only the grinding of sugar and the cultivation of the cane and tobacco that would give employment to the masses of immigrants. Just as the United States are able to supply all the wants of their great population because of the diversity and abundance of their agricultural and manufactured products, so could Cuba supply her population, if her natural resources were worked out, and at the same time export to other countries.

All the leguminous plants and cereals grown in North America, and the seeds of which have been imported into Cuba, grow there even more luxuriantly. The cultivation of farms supplies the great centers of population, but is confined at present to small strips of land contiguous to the cities of Havana, Matanzas, etc., the farmers never having pretended, as yet, to supply the demand of more distant markets. The rice grown in the southern States or in India is not more nourishing than that produced in Cuba, and yet the island does not supply even the local consumption. The Cuban corn is unsurpassed in its farinaceous principles, and yet it is raised there only to a small extent. Wheat has been grown on an experimental scale with complete success; nevertheless, it is not cultivated, and the country is compelled to pay high duties on foreign flour. Besides, there are numerous indigenous plants which are very rich in nutriment and quite suitable for food, such as the tamarind, peas, beans, lentils, etc.

The great variety of the Cuban fruits is the wonder of the foreigner who visits the island, and has taken up many pages in the botanical catalogues. This important branch of agriculture is entirely neglected there. The New York *gourmet* who delights himself contemplating the beautiful peas, apricots, plums, and raspberries which are brought daily to the markets and which the western trains bring within reach of his hand has no idea whatever of the immense quantity of delicious fruits which grow almost wild in the Cuban plains, to say nothing of the banana, of which there are many varieties and sizes, and to the cultivation of which the Baracoa district is devoted, or of the cocoanuts or pine-apples, for which there is a great demand in the United States, or of oranges, which are superior, by reason of the perfume of their peel and the sweetness of their acidulated juice, to those from Florida; in fact, there exist there so many kinds of delicious fruits that, were their cultivation and improvement entrusted to the hands of skilful planters, they would become an important source of wealth. Such are, for instance, the limes, sweet grape fruit, citron, sweet sapote, the white and purple caimito, two kinds of mammee sapotas, anon, mangoes, chirimoya, guanabana, pomarosa, canistel plums, watermelon, and many others, the enumeration of which would occupy too much space, but none of which fail of importance if we take into consideration the sweetness of their pulps, their nourishing and healthful juices, and the uses to which they may be applied. The cultivation of strawberries, peaches, pears, and apples has been successfully tried there, and it has been affirmed that the soil of Cuba, which produces a kind of wild grape, is as fit for the cultivation of the vine as that of California, which now shares this industry with Europe.

Figs are grown in the gardens in great profusion, but are cultivated only for pastime.

The exploitation of medicinal and aromatic plants, of which there is a great variety, is as yet in an embryo state in Cuba. They are neither exported or employed in commerce to any extent, or utilized at home as domestic remedies. In this class belong the red Indian dwarf pepper, the sweet basil, mint and peppermint, wild and sweet marjoram, thyme, balm-gentle, chamomile, royal itamo, salvadera, and the higuereta, from which castor oil is extracted. In the marshy lands, near the coast, shrubs called mangles, from which tannic acid or tannin is obtained, grow in great profusion. In the woods are to be found copal and resin, rich sources of essential oils or spirit of turpentine, to say nothing of the immense amount of resin which the innumerable pine forests of the province of Pinar del Rio would yield.

There are many indigenous textile plants; cotton grows wild in the fields and forests, of a quality equal to that grown in Virginia, but not a single bale has ever been packed; the cultivation of ramie, hemp, and the Indian fig are awaiting development in great stretches of land at present uncultivated. It has been practically demonstrated that there are lands in Cuba most admirably adapted to such cultivation; if attempts in this direction heretofore have failed, it is owing to the exorbitant duties imposed upon imported machinery, besides many other exactions and impositions which are simply ruinous in their effect.

There are undeveloped fields in Cuba, even where the appearances are more unpromising and insignificant. In New York, in Philadelphia, in Chicago, in all cities of any importance here as well as in Europe, floriculture is a profitable occupation; yet the cultivation of gardens is completely neglected in Cuba. On the banks of its rivers, brooks, and ponds, on its virgin mountains, flowers are seen perpetually blooming in most brilliant variety, filling the fields with their exquisite perfumes and entirely neglected by the botanist.

But there is no richer field for enterprise than the one offered by the precious forest woods, which afford an excellent material for building purposes. It is impossible to enumerate them all. Cedar, mahogany, ebony, the royal palm, oak, pine, are names familiar in North American markets. The same is not true of quiebrahacha, acana, hocuma, jiquí, yaya, dagame, macagua, and a hundred more which are as yet almost unknown, but eminently fit, on account of their hardness and dimensions, for naval constructions. And for cabinet work there is a great variety of fancy woods, with beautiful veins and exquisite shades, famous for their strength and elasticity; as the sabina, sabicú, caracolillo, granadillo, guayabo, etc.

There are so many agricultural possibilities as yet undeveloped in

the most fertile lands of the island, so aptly termed the Pearl of the Antilles, that many pages might be written simply in their enumeration and description. At present, the condition of Cuba may be compared to that of the western territories when they were controlled by the Indians; that is to say, it awaits the influx of an intelligent and industrious population to bring activity, money, machinery, railroads, modern appliances, agricultural implements, in short, everything which would tend to draw from the fertile soil the wealth that lies hidden there. But, if so many opportunities for the development of new industries are lost for lack of population and cultivation, what might not also be said of the medicinal mineral waters which flow in great abundance in the mountainous regions and, were they known and their healthful properties appreciated, would certainly be in as great demand as Apollinaris? The renowned watering-places of San Diego, Madruga, Santa Fe, and San Miguel, recommended by wise European hygienists, but at present entirely neglected, would be sufficient in themselves to yield great profits to those who develop them.

The coasts of Cuba, especially in Vuelta Abajo and the central provinces, are rich in salt mines, whose deposits are wasted, inasmuch as this industry has never been developed and the article used in home consumption is imported from Spain or other countries.

The Cuban fish is not a whit less nourishing or palatable than that to be found in the waters of Gascogne or Nova Scotia. There is no doubt that the canned-fish trade and the exportation of the product would yield great profits. The eminent Cuban naturalist, Poey, exhibited at the Amsterdam Exposition a description of seven hundred and fifty-eight species, from the salmon and codfish down to the delicious sardines so highly prized by all good livers, to say nothing of the species peculiar to those waters, like the pargo, cherna, guaguancho, etc. The Cuban oyster, more highly flavored than the American article, richer in nutritious elements, is propagated to an infinite extent in natural beds, in spite of the fact that these have not been subjected to modern improvements.

Cuba has been explored, but not developed. Not even those incalculable quantities of guano stored away in its numberless mountain caves—such as Cotilla, Candela, Cubitas, and the labyrinths of Escambray in the eastern department—have ever been gathered, notwithstanding the fact that it is an excellent manure, fit for exportation, and would command high prices in foreign countries. What wonder that such is the case, when we there find all mining industries neglected, and the rich subsoil as yet untouched by the hand of man!

Cuban mineralogy has been the object of deep study on the part of foreign and native *savants*. Among other authors who have devoted

their enthusiastic attention to it we may mention Le Sagra and Baron Von Humboldt.

There are gold mines in Holguín, Cienfuegos, Trinidad, Santa Clara, and San Juan de los Remedios; copper and silver mines in Santiago de Cuba and Puerto Principe; iron mines in Sierra Morena; magnetite mines in Juragua, Bayamo, Nuevitas, and Cubitas; asbestos, sulphur, mica, mercury, and coal in several other sections of the island; serpentine in Guanabacoa and Trinidad; quartz and feldspar in Escambray and Pinar del Rio; agate, carnelian, antimony, granite, chalk, asphalt, baryta, and petroleum in several other sections, and an abundance of white and colored marble. In short, there are mines, but not miners, in Cuba. There is a total absence of mining enterprise.

English and American capitalists undertook, some years ago, to extract from the mines of the east, on a small scale, the iron, copper minerals, manganese, and asphalt which they contain, and they have been exported in the following proportion:

Iron	400,000 tons.
Manganese	800 "
Asphalt	1,000 "
Copper	200 "

When the onerous custom duties which actually bar out the powerful machinery manufactured in the United States shall be removed, and the mining industry freely and vigorously prosecuted in Cuba, then the credit which that privileged island enjoys abroad because of its wonderful natural resources will be greatly strengthened.

Cubans, owing to causes which we will not here mention, have committed the grievous error of devoting their whole energies to the sugar and tobacco industries. A naturally industrious, bright, and persevering people, struggling against the numerous legislative hindrances which actually handicapped their individual faculties, the Cubans sought a fanciful compensation to their efforts in the bright prospect which the sugar and tobacco industries seemed to offer them.

They gave up the raising of cocoa, which yielded a very profitable return, and was exported to a considerable extent; they also neglected coffee, which competed favorably, in flavor and quality, with Mocha, and was at one time one of the most favored staple products of the island; they likewise abandoned the minor agricultural industries, until they so far failed to yield the necessary supply for home consumption as to compel workingmen to depend upon canned goods imported from the United States; they entirely lost sight of the fact that the potato crop of a single section—the municipality of Güines—amounted to two million dollars in one year; they entrusted the cattle

industry entirely to the farmers of Sancti-Spíritu and Puerto Principe, where, up to the year 1894, over 3,000,000 head of cattle had been gathered,—a sufficient number for home consumption ; and they devoted their energies almost exclusively to the sugar and tobacco crops.

Their aim was to become the greatest sugar-producing people in the world, and at one time they succeeded in their purpose. But they overlooked the fact that foreign competition and the lack of official protection, together with the overwhelming taxes at home, would surely ruin their business, cripple their country, and disturb the equilibrium of trade, through the lack of other compensating industries.

Whatever may have been the consequences, it behooves us only to point out that the tobacco grown in Cuba is the best known in the world ; that the Vuelta Abajo leaf is universally famous ; and that all competition by the tobacco-growers of Kentucky, Virginia, and the French and English colonies has been of no avail, the superior quality of the Cuban leaf being due to the climate and the soil.

Cuban tobacco has been exported to the United States as follows :

YEARS.	LEAF TOBACCO.	CIGARS.
1889.....	5,600,000 pounds.	3,500,000
1890.....	7,100,000 "	3,900,000
1891.....	7,100,000 "	3,300,000
1892.....	7,900,000 "	2,800,000
1893.....	8,900,000 "	2,700,000

According to late statistics, the United States has recently imported yearly from Cuba 13,950,000 pounds of leaf tobacco and 983,893 pounds of cigars.

The remarkably fertile soil of Cuba seems to have been especially endowed by nature for the cultivation of the sugar cane. There are sections, like eastern Cuba, where canes attain a growth of thirty feet in height and five inches in diameter. They contain a prodigious amount of saccharine matter.

The number of plantations which were working in Cuba during the season 1893-94 was 409, and the sugar production reached in that year 1,017,612 tons. During the ten previous years the average was 612,000 tons a year. When the production of sugar was not so extensive as it is at present, and competition was much less, Cuban sugar reached a price as high as $90, $100, and $134 per ton. The excess of production has lowered the price. To-day it commands less than $60 a ton, and the business is weighed down by great hindrances in the form of export duties, duties on machinery, internal taxes, and by the total absence of official encouragement and protection.

In short, if, in order to duly appreciate the opportunities and inducements offered to American capitalists and to open the way to im-

migration, a careful study is made of the topography, geographical situation, means of transportation, and other features which may tend to improve the endless natural resources of that land, one is irresistibly drawn to the conclusion that it is destined to become the Mecca of all future American enterprises.

The island, as is well known, lies at the entrance of the Gulf of Mexico, and has a length of 816 miles on the north and 903 on the south, and an area of 34,716 square miles. Its smallest width is 22½ miles, and its greatest width 135 leagues. Its long sea-coast is indented with all kinds of ports, harbors, bays, creeks, etc., as yet unopened to commerce and navigation, but which must surely invite the genius and enterprise of a thrifty and ambitious people, since they could, in combination with suitable railroads and adequate means of river navigation, afford an outlet for the immense and as yet undeveloped products of that marvelous land.

The climate is delicious. In summer the temperature ranges from 70° to 84° F., and the heat is tempered by a perpetual sea-breeze. In winter the mercury never goes lower than 50°.

There can be nothing more undeserved than the unsavory reputation which the climate of Cuba has acquired. Yellow fever is prevalent in some places, like Havana, not on account of the climate, which is absolutely healthful, but through the lack of an efficient board of health, and the filthiness of the ports, entirely neglected by the government. Just as in Florida the plague has been banished by wise regulations, so the same results will surely be attained in Cuba after the reorganization of the country.

The roads are few and primitive; communication is difficult, and at many points of the country travel is impossible. There are only three roads in the province of Havana, and these but thirty-six miles in length,—one leading to Güines, another one to Guanajay, and a third to Marianao.

As to railroads, there are only 1,500 kilometers in operation, although the country is in sore need of them, as the small local affairs rendering service for the plantations are scarcely worth mention.

The Vuelta Abajo district, where the renowned Cuban tobacco is produced, will become an emporium of wealth when new roads and other means of communication carry the products of that privileged region promptly and easily to the neighboring ports of the north and south coasts, which at present are entirely neglected.

The province of Santa Clara is more sorely affected in this respect than any other. There is urgent need of a railroad connecting this province with that of Puerto Principe, the great cattle-raising province (where a complete system of railroads has become an actual necessity),

and with the eastern department, where the mining industry and the fruit trade with the United States have their seat.

All these splendid opportunities are loudly calling for the investment of American capital, to say nothing of the cities and towns where electric, cable, and other railroads would be gladly welcomed by the people. Havana is the only place where street railways are to be found, and there only in a very primitive state, wholly dependent upon animal power. There is also a vast field for investments in gas and electric light companies, as well as in water works and other modern improvements.

Finally, the machinery which is now imported from Belgium, England, and France, and which can be more advantageously provided from the United States, constitutes another powerful inducement for American enterprise. In fact, the whole island is open to the wide-awake genius of this country.

How could all this be accomplished?

By modifying the present commercial relations between both countries; by establishing an equitable and close intercourse between them; so that by reciprocity treaties, or through other more efficient, solid, and sympathetic means, free trade should be firmly established between Cuba and this republic.

What should this means consist of? Only the future can answer this question. Cuba on the south claims her rights and opportunities, as California and the remote regions of the west claimed theirs. Four-fifths of that fertile country is as yet unbroken land, where three yearly crops are obtained, where there are innumerable mining resources, where virgin forests abound, and where there are, in a word, countless opportunities for labor and capital.

Cuba is nearer and more accessible than the Pacific States. Her ports are only fifteen hours from the most southern ports of the United States. It is now possible to travel from New York to Cuba in seventy hours, and facilities will increase with the establishment of better steamship lines. It would be possible to manage a railroad system, or any other concern having its field of operation in Cuba, from New York, Philadelphia, or Boston, with less difficulties than those encountered by the managers of the Oregon or Arizona enterprises.

On the other hand, Cubans are well aware that their destiny is closely allied to and dependent upon their most intimate relations with the markets of the American union. Let us confidently await the time when, through mutual agreement, Cuba shall become a veritable emporium of agricultural and industrial wealth, and cease to be merely a wonderful, but unproductive, field of natural resources.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

V.—THE NEWER TYPES OF METAL-CUTTING MACHINES.

THE machine-shop superintendent desires to produce the most work for the least cost. The work consists wholly in changing metal forms, by founding, by forging, and by cutting; these changes in metal form are produced partly by natural, unintelligent agencies, and partly by the efforts of the workmen. Fire and water; the stream of melted metal flowing into the mould; the hammer and anvil; the hammer and chisel; the muscles of the moulder, the blacksmith, and the whitesmith,—these were the agencies by which Tubal Cain and the builders of Solomon's Temple wrought their marvels, and they are the agencies which the machine constructor must employ to-day. There has been no broad change in the means of working metals and changing metal forms from the very first until now, excepting electro-plating, and that marvel does not greatly affect machine construction, because of its comparatively great cost and the uncertainty of its results in large masses.

The hammer and chisel, the file and the lathe, and the workman are still the agencies with which the machine-shop superintendent must do his work, and the single problem of the superintendent's shop-life is to find the most effective use of these simple agencies, to learn how to make the greatest change in metal forms with the least cost, and so build the most machinery for the least money.

Labor is the costly factor in machine production; the shop and tools, once furnished, stay there; they last long and cost little for maintenance or renewal; labor is a constant and great expense; the most work for the least labor is immediately seen to be the real problem, and its only solution lies in making machines build machines, instead of using men for that purpose. In case of a simple form of small machine, like a pin or a cartridge-shell or a screw, manual labor can be almost wholly replaced by machine work. A screw-making machine may work for an entire day, or sometimes for several days together, without being touched by the hand of man. Even in the case of pieces weighing hundreds of pounds, suitably-contrived machines can reduce the labor cost of finishing to inconsiderable sums, so that the very same operation might have a labor cost in one good machine shop of, say, a dollar, while in another shop the labor cost would be only ten cents, the difference in the two shops being that the one is fitted for general work only, while the other is supplied

with special agents for producing this particular form of piece. The superintendent is, therefore, confronted at the outset by the problem of tools specially suited to his work. He sees a tool, fitted for a certain operation, reduce the cost of that operation to a small fraction of its cost by ordinary methods of finishing, and draws the general, and true, conclusion that equally suitable tools for his entire range of operations might vastly reduce the total cost of his work. Following this conclusion, he also sees that no shop can be large enough, and no shop-owners can be rich enough, to equip a shop in the best manner for making all kinds of machines, and this leads at once to the special shop, fitted with specialized tools for the production of one particular machine. He sees also that the general shop can draw revenue from many near-by sources; his own shop may have an established and valuable trade in many different lines; if all but one of these lines of production are abandoned, then he must go far afield to market his wares, which means a vast selling expense connected with his cheap product, and the concern's eggs all in one basket; rivals may enter the field, close competition may follow his successful efforts, and ruin supplement his most triumphant success in production of the single thing.

The old shops began with the hand-lathe about a hundred years ago, as the sole machine tool. All that could not be done on the hand-lathe was done in the smith shop, or with the hammer and chisel and file. Everything else has come into the machine shop within the last hundred years, and almost all of it within the memory of men still in service; and all that we now call modern or regard as effective is of very late construction indeed. Fifty years ago the iron planer was a special tool, and there was not an efficient engine lathe in the world perhaps,—certainly not in America; drilling machines, milling machines, and chucking machines were generally not known at all, and where some raw, inefficient form of either of these machines was known, it was regarded as a doubtful experiment, and the milling machine, in which the multiple-cutter idea is carried to the ultimate, is still an uncertain factor in machine production.

The well-informed, broadly-seeing superintendent passes this review of the old days before his eyes, and sees that the end has not been reached; that he may yet vastly reduce the labor cost of his product by improving his metal-cutting machines; and that more roads to prosperity will be open to him if his improved tools are general in their field of usefulness than if they are narrowly limited in lines of efficiency. He can draw but two conclusions: he must either select one specialty, and sink or swim as he fails or succeeds in his effort to lead his rivals; or he must use the best general tools which he can buy or make, and must reduce the labor cost attending these

superlatively excellent general tools to the lowest possible figure, and so be prepared to meet general demands for machinery with the most efficient and economical means for general machine production. If he has an old and inefficient plant, he must throw it away, either piece-meal, or in a lump. If he has workmen whose motto is "a fair day's work for a fair day's pay," he must either have a new force, or he must change the views of his old hands. And he must work his changes slowly, gradually, imperceptibly almost, or he will lose the confidence of his employers and antagonize his men, and end in the disreputable loss of his position. It is the superintendent who must order the shop equipment, and must direct changes and be responsible for economic production; hence the superintendent is here treated as the principal. The owner and manager desires cheap production, but he does not desire to make a large outlay to secure this low cost of work; his tools were the best at the time of purchase, and the manager is loth to believe that these one-time masterpieces are not still the best of their kind, or so nearly equal to the best as to make any wholesale replacing of his plant not only needless, but absurd. Yet the competent and well-informed superintendent knows perfectly well that he could double, treble, or quadruple the result of an hour's work by the use of tools that are not experiments, but thoroughly tried successes. Some of his tools are too light to take the heavy cuts which work would stand; other machines which might well have several tools in simultaneous cut are fitted with only a single tool post; a hand is attending but a single machine, or perhaps two machines, where he might as easily, or even more easily, attend four, six, or eight machines, each doing as much as or more than the single machine which now occupies the entire time of the almost idle workman. It is only in the last ten or fifteen years that the haughty machinist has condescended to overlook two machine tools at work, but now the cry of "spoiling trade," and even the theory that the smaller the day's work performed the more days' works there are to be done, have been abandoned by the greater part of machine-shop workers, and there is no objection to increasing production by having one man attend all the machines possible.

Nothing here advanced applies to the repair shop, or, strange to say, to the river-boat engine shop. The repair shop demands nothing more than fairly efficient tools in as great a variety as possible, but both the repair shop and the river-boat engine shop, and indeed the general machine shop except for very heavy work, are rapidly passing out of existence; they will not disappear entirely, but they will never again be of great importance.

Supposing a machine shop, having its established line of work in

demand, to be well lighted, floored, ventilated, capitalized, and suitably supplied with cranes and hoists, and generally so equipped as to avoid all needless losses in transportation and handling materials and work in progress, and supposing it to have a plant of metal-cutting tools bought ten or twelve years since, which are still in fair working condition,—what course is dictated by real economy?

Each hour of labor should give the largest attainable result in finished product. Upon this axiom manager and superintendent are agreed. From this common base line, however, they travel in lines separated by a wide angle of divergence. The manager wants to use the old tools, while the superintendent wants to put the respectable, well-preserved, antiquated money-eaters in the scrap-heap or the second-hand dealer's warerooms, and install the best he can buy or build in their place. The manager knows the old tools are good enough; the superintendent knows they are not worth shop-room as a gift, or even that they would not be worth taking as a gift with a yearly bonus of ten or twenty or thirty thousand dollars added.

In this case, which is common enough, the wise superintendent will select the most general operation in the shop,—lathe work, boring, planing, drilling, or whatever it may be,—and quietly either alter an old tool to his mind, or buy one new tool of the greatest possible efficiency for that particular purpose; he will put an ambitious young man or cub on this tool, and tell him to show the old hands what he can do; he will double, treble, or quadruple his former per hour output. Cost cards will be compared by the manager, who will probably, if the superintendent shows a disposition to rest on his success, begin to urge the adoption of means to make like savings throughout the shops, although he would have previously opposed any change, and so the tool-replacing is inaugurated.

Suppose an engine lathe costs $500, and money is worth 5 per cent., and that the tool depreciates 10 per cent. yearly, and so becomes valueless in ten years; suppose also that the yearly wage of the workman who runs this lathe is $500. The total cost of this lathe for its lifetime is $750, exclusive of driving power, belting, repairs, and shop-room, and the total cost of labor to run the lathe is $5,000. Suppose this lathe finishes 20 short shafts daily, two cuts over, ready for filing and polishing, with a single tool, finishing cut followed with the callipers, 300 days in the year, 60,000 shafts in its lifetime costing $5,750.00÷60,000=$0,09416, or nearly 9½ cents each for lathe work. The management resolves to make better work for less money. The tool cost is $750, and labor cost is $5,000 for the life of the tool; obviously any great gain must be made by labor-saving, as the tool cost is small. The belt cone with 4 steps for a $\frac{2}{3}''$ belt is replaced by

a 2-step cone for a 4″ belt, another tool post is added on the back side with an inverted tool, and a hollow-mill sizer is placed in this tool combination to follow the two tool cuts, so that one cut over finishes the same shaft in half the time, and the workman does not need to follow the finishing cut with the callipers; as it takes but one minute to change pieces in the lathe, he has time to spare; he is offered the work at piece prices, and is willing to exert himself to increase his own earnings; four similar lathes are added, making a total of five, each finishing forty shafts per day, a total of 200 daily, 60,000 yearly, or 600,000 for the ten years' life of the plant: there is an added charge for tool-making and power and shop-room, but these items make but a small aggregate; the management is liberal in its views, and permits the workman to double his pay and earn $1,000 yearly. Flooded lubrication of the work and the balanced cut of the two tools make the lathes last as long as before, though doing twice the work. The total cost for ten years is 5 lathes, $500 each, $2,500; interest, $1,250; labor, $10,000; total, $13,750 as the cost of finishing 600,000 shafts, or a little less than $2\frac{3}{10}$ cents per shaft, against the original cost of about $9\frac{1}{2}$ cents each, or a saving of, say, 7 cents on each piece = $42,000 total saving on 600,000 shafts, or a yearly saving of $4,200, while the workman's pay has been doubled. By the first conditions the yearly product was 6,000 shafts at a total cost of $575; with the improved plant 6,000 shafts cost $138. This hypothetical case was almost exactly paralleled by the Mason Machine Shop with special lathes for finishing carding machine cylinders. I have not the exact figures, but believe the percentage of gain to have been greater in the real than in the supposed case, which is given because its simplicity makes it easily understood. First, the work must be wanted; next, driving power must be increased both in the office and the shop; finally, one man's labor must be made cover the use of more cutting edges. The work of each cutting tool edge may be increased vastly beyond the practice of some shops. In other shops machine tools and labor conditions are such that each cutting tool is made to do all it can. Every agent of production has its limit of effect, and the most economical results are obtained from use well within the powers of the agent, whether the agent be a man, or a horse, or a driving belt, or the cutting edge of a metal-working tool. The best practice possible consists broadly in furnishing ample driving power, rigid tool support, multiple cutting edges, and in many cases, and possibly in all cases, flooded lubrication of cuts in progress. No experiments are recorded of the effect of lubrication on cuts in cast iron, which is still cut dry; until very lately, it was supposed that different metals required different lubricating materials, but the latest

and best automatic screw-machine practice proves conclusively that flooded lard-oil lubrication is best for iron, steel, and wrought and cast brass, although brass is still worked dry in many and perhaps in the majority of cases. The best screw-machine practice within my knowledge is that of the Lozier Cycle Shops, at Thompsonville, Conn., where the whole place is piped with the best lard oil from a single set of pumps, and all cuts of every description are flooded with this single lubricant. Forced lubrication is indispensable in some cases, and a most important aid to economical production in all cases, high pressures of 200 pounds to the inch or more being essential to the best production of some cuts. Water, and soda-water, and soap and water, can be used to great advantage on heavy work, but it is not in heavy work that enormous savings in finishing and cost can be made, although it is highly probable that steam-engine finishing now costs but little more than half, or possibly but little more than a third, what it did ten years ago. Seven thousand horse power of Corliss engines was lately contracted at 3½ cents per pound, which indicates recent great reductions in labor on work of this class. The modern large boring mill, with two or three cutting tools in simultaneous operation, greatly cheapens the cost of a large class of work. The iron planer has had its effectiveness increased in two ways,—by increasing the number of tools, and the length of the bed, so as to permit the placing of many short pieces at once. In some cases twelve or eighteen planer tools are in simultaneous cut on one planer; in other cases, one man attends several planers; in other cases, the piece-worker abandons the use of automatic feeds of uniform width, and feeds the tools by hand for roughing large work. At the Baldwin shop locomotive frames are planed two at a time, on special Sellers planers, at an incredibly low cost. At the Hendey Norton Lathe Shops, Torrington, Conn., a six-foot engine lathe bed is sometimes planed for less than one dollar, on a special long table machine, with several tool carrying heads. Lack of space forbids particulars, no matter how interesting or pertinent. I can do no more than simply assert the bare outlines of most advanced practice; the lowest-cost work is being constantly cheapened, and the factors of cost reduction are rigid tool support, abundant driving power, multiple cutting edges, and forced lubrication. These things are perfectly recognized and fully understood by some managers and superintendents of to-day, and machine-tool makers are being gradually forced to meet the requirements of such buyers. I use the word "forced" advisedly. The good and successful machine-tool builder must follow the public demand. He cannot create it, and cannot hurry it.

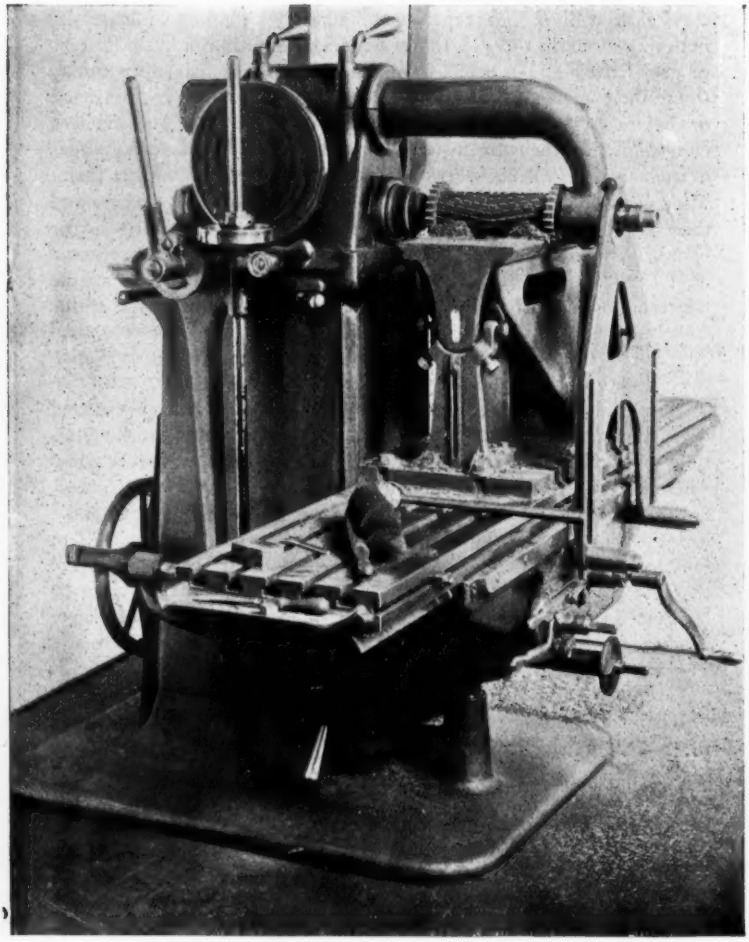
As for the users of old tools, the managers who proudly cherish

and tenderly preserve a museum of machine-tool antiquities, nothing can improve their condition short of a sheriff's sale. Such shops may earn a living at repairs and foundry jobbing by carefully pottering along in the old tracks with a constantly-diminishing force of grey-haired and spectacled old-time machinists, standing to-day where their feet wore holes in the floor twenty or thirty years ago; or they may close the doors over their grass-grown thresholds in silent confession that they are distanced in the race. There are hundreds of such shops in the country, and there is but one fate for all of them. They must change or quit. And it is not enough to put in here and there a new tool among the hoary wrecks which they dignify by the name of "tools," as in a case which I saw very recently, where a large Gisholt turret chucking machine stood at one end of the machine floor and a Cincinnati Milling Machine Company's milling machine and cutter grinder at the other end, and nothing of later date than 1870 between them. "Times are not what they used to be," said the old man in the neglected office; "business is dull."

Powerful drillers, banked for the smaller work, radial and provided with pits, large sole plates, and work carriages for heavy work; multiple tool boring-mills and planers, the later with 30- or 40-ft. tables where demanded; modern chucking machines, and pulley and wheel-finishing machines, making from three to five simultaneous cuts; turret machines of all classes, from the Brown and Sharpe "pony" to the heaviest Niles or Gisholt; the flat turret lathe in its late form, and that yet unknown quantity, the milling-machine, now built in its heaviest patterns by Ingersoll,—these are the factors of cheaper machine work within reach of the ambitious superintendent to-day. For work which must approach accuracy the grinding-machine is indispensable, and the various forms furnished by Brown & Sharpe, Landis, and others can be relied upon to produce really good work more cheaply than will any other means.

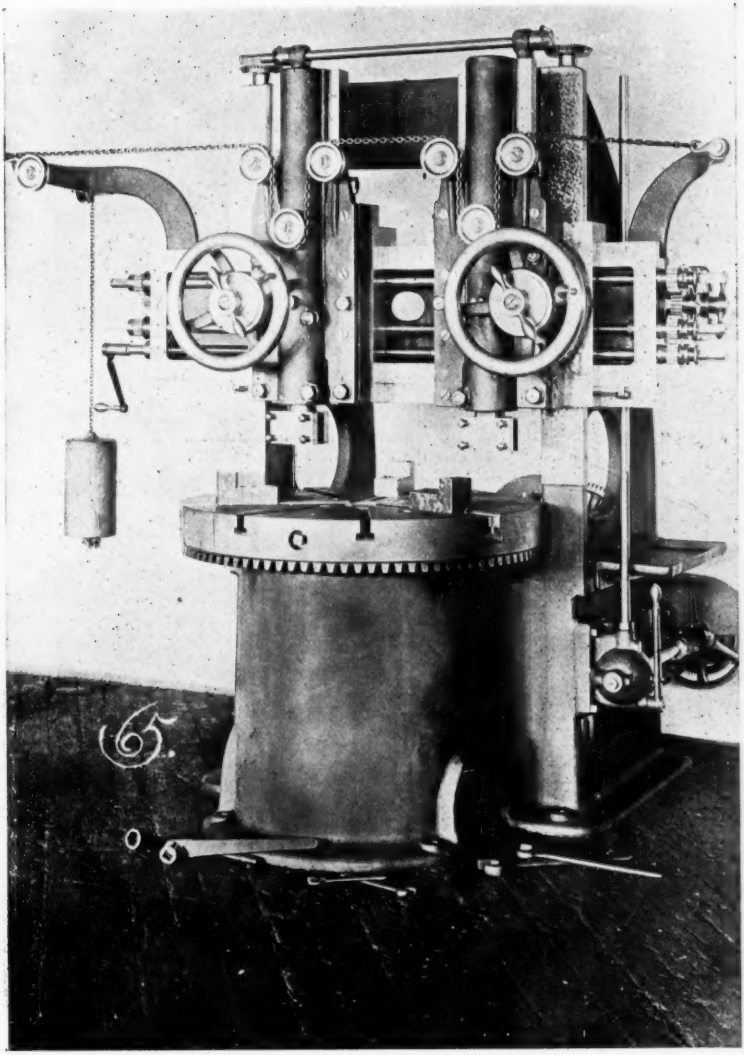
To reach the most economical production both manager and superintendent must rise above that conservatism which is but the natural indisposition of the human mind to admit the superiority of others. The manager must desire cheaper and better work, and the superintendent must find tools and men to gratify this desire, and both must understand that the success of yesterday has passed never to return, and must fully and faithfully believe that the dream of to-day may be the wealth-producing fact of to-morrow.

NOTE.—The illustrations for this article, representing advanced types of metal-cutting machinery, are bunched on the following pages.



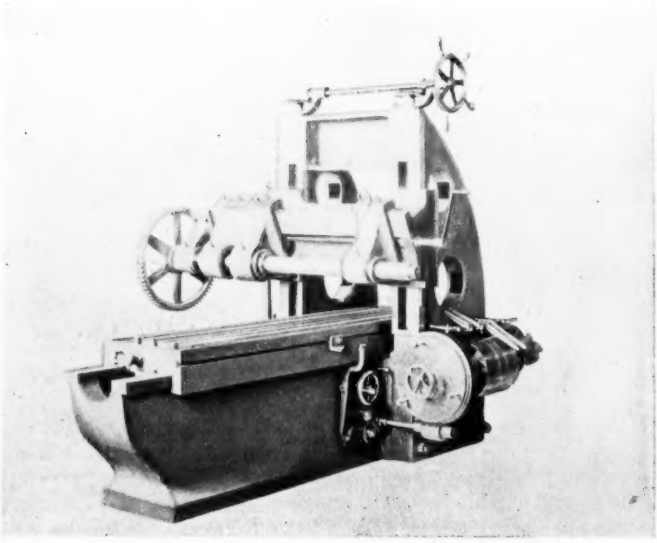
NO. 24 PLAIN MILLING MACHINE,

In operation on Milling Machine Knee. Brown & Sharpe Mfg. Co., Providence, R. I.

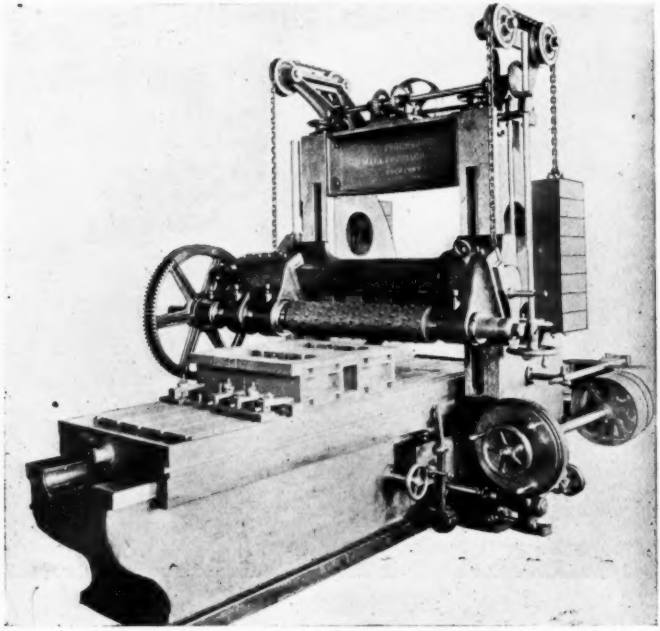


37" BORING AND TURNING MILL, WITH TWO HEADS.

Bullard Machine Tool Co., Bridgeport, Conn.

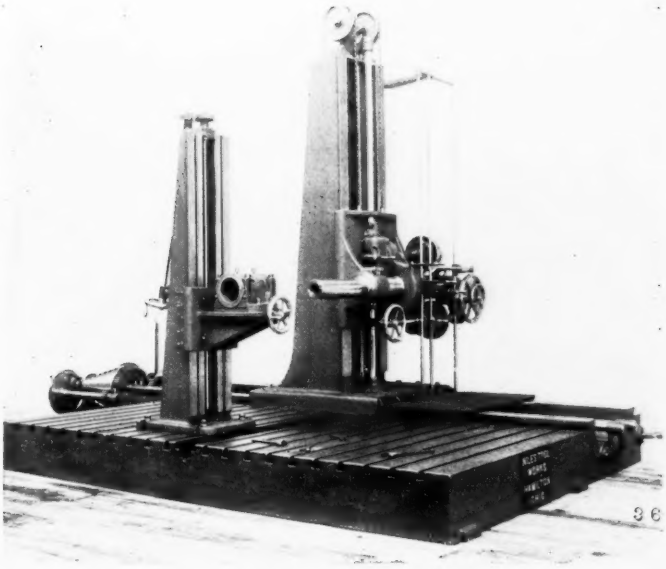


INGERSOLL SLAB MILLING MACHINE, 24" X 24" X 72".

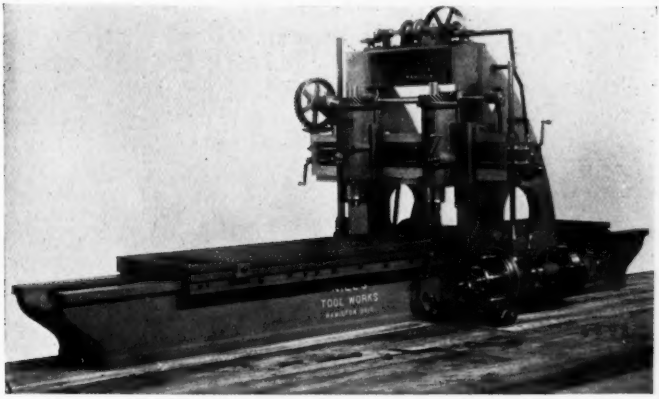


INGERSOLL PATENT SLAB MILLING MACHINE,

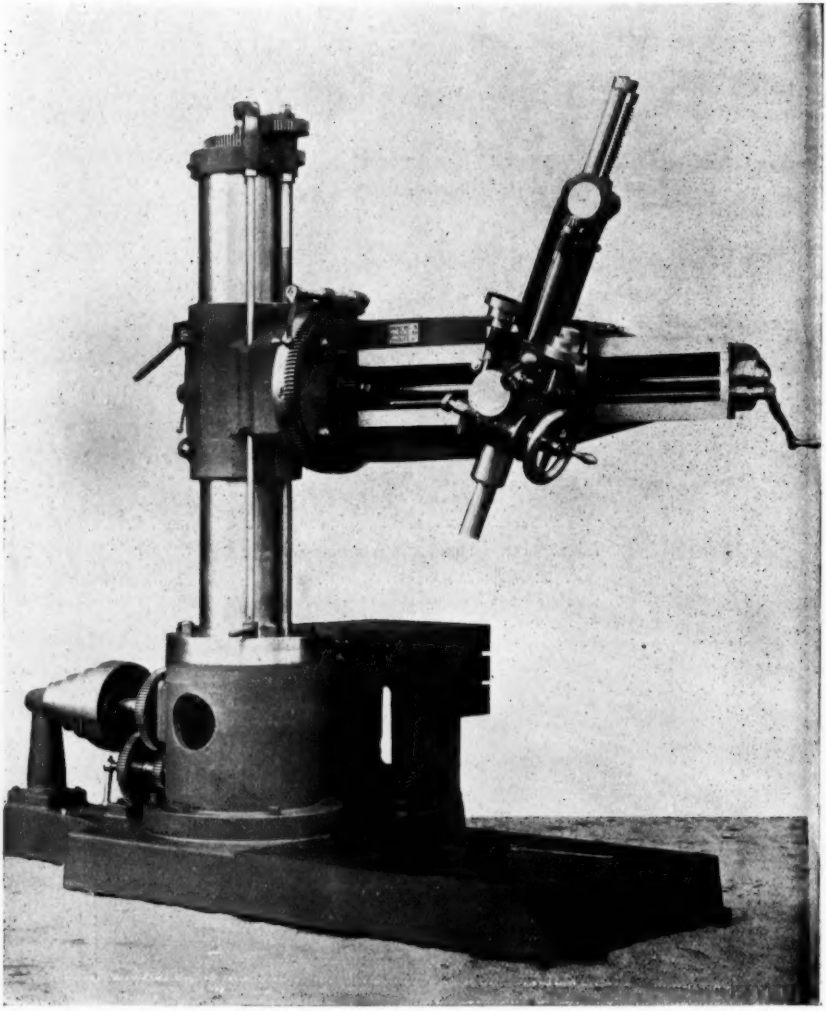
With Ingersoll Patent Cutter, shown milling 30" wide, 4" per minute. Ingersoll Milling Machine Co., Rockford, Ill.



HORIZONTAL MILLING AND BORING-MACHINE.
Niles Tool Works, Hamilton, Ohio.

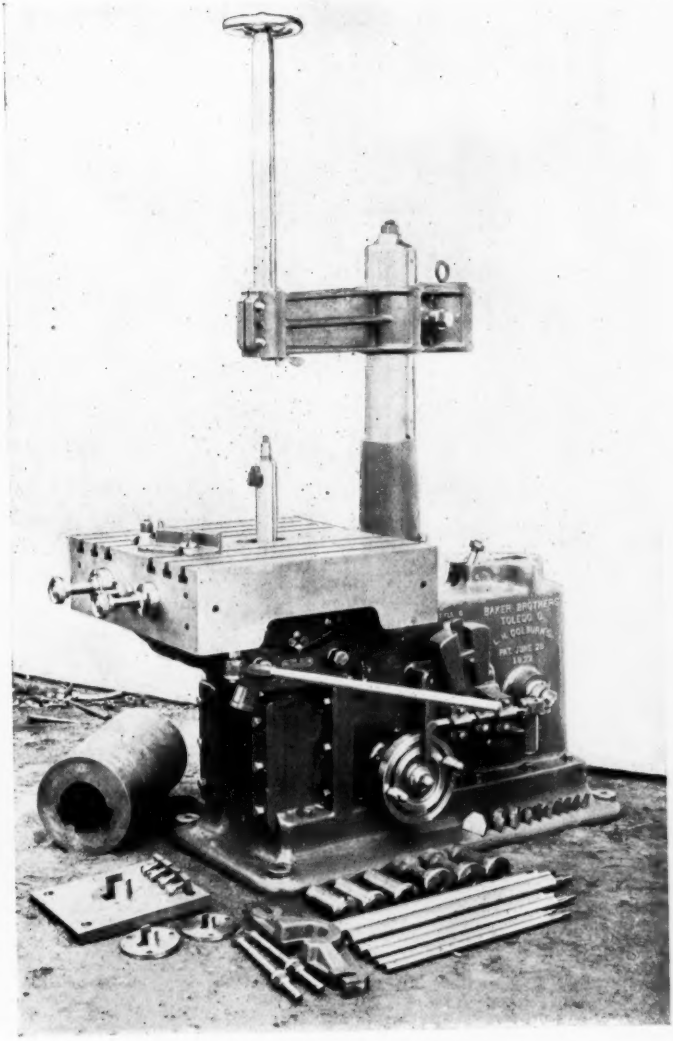


DOUBLE-SPINDLE VERTICAL MILLING MACHINE.
Niles Tool Works, Hamilton, Ohio.



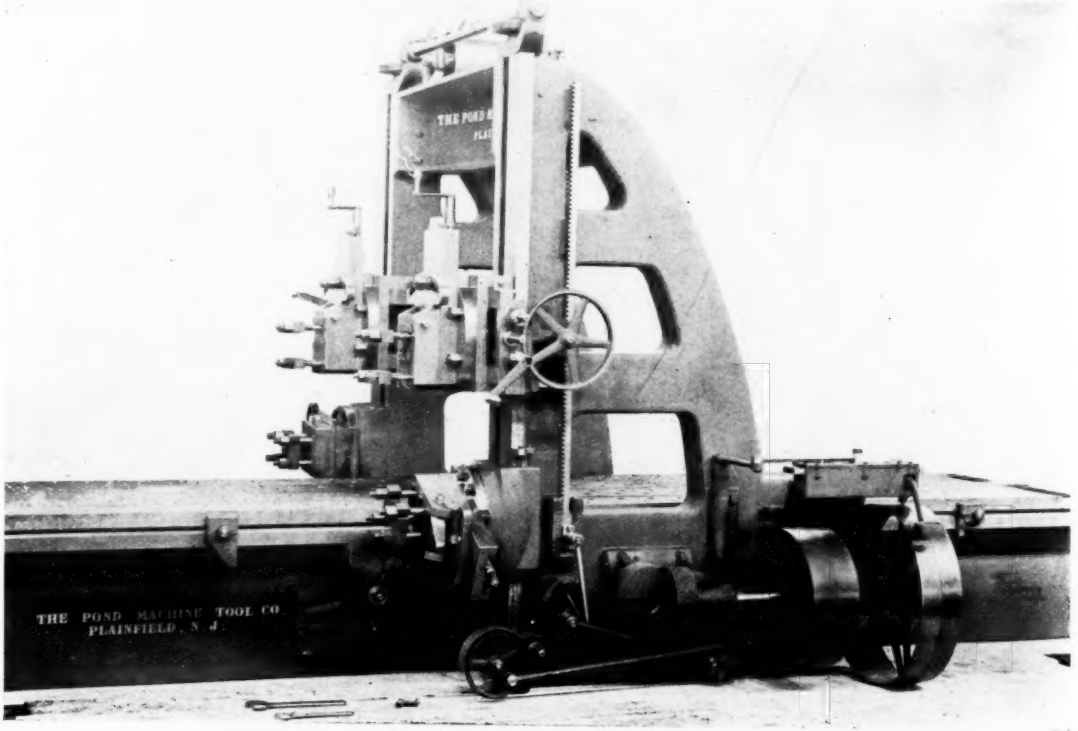
FULL UNIVERSAL RADIAL DRILL.

Bickford Drill & Tool Company, Cincinnati, Ohio.

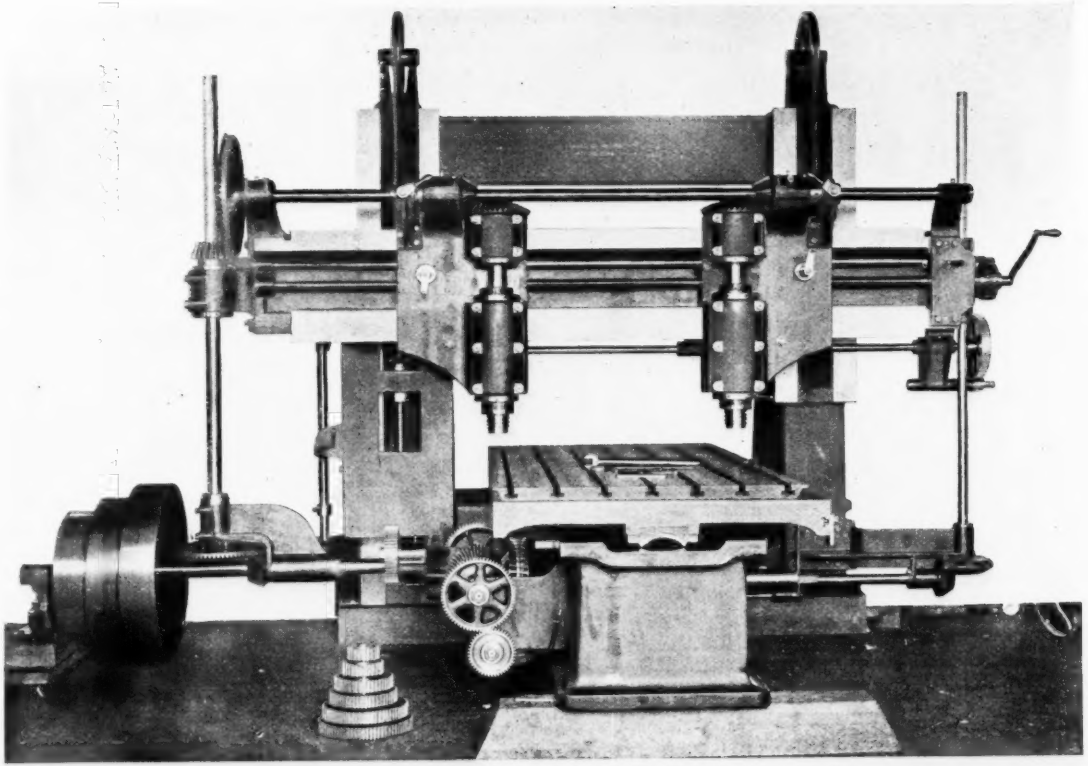


COLBURN KEYWAY-CUTTER.

Baker Bros., Toledo, Ohio.

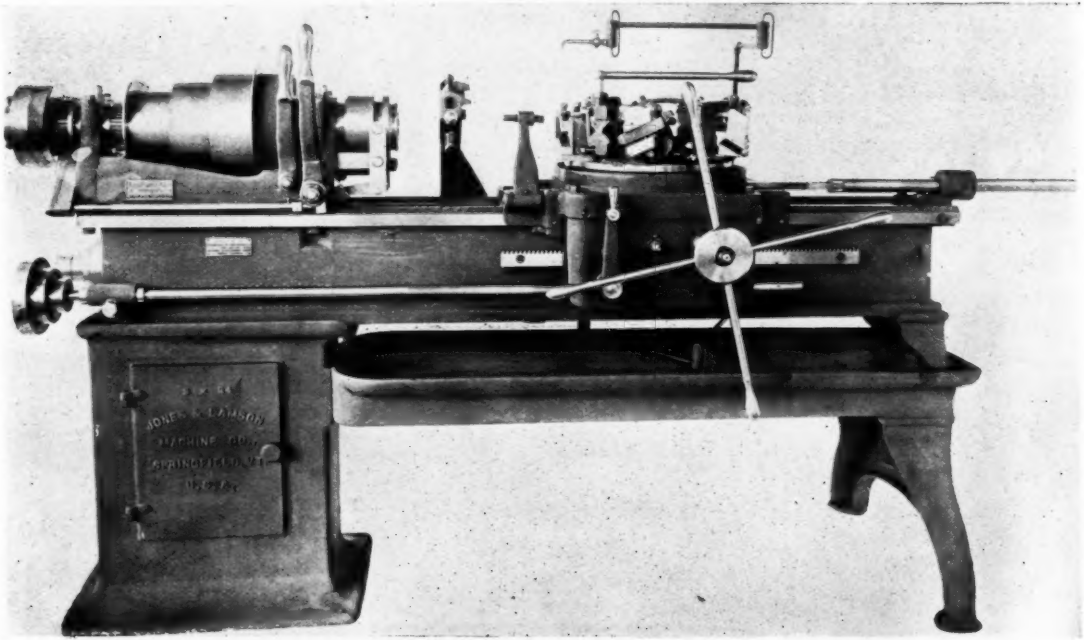


60" PARALLEL PLANER.
Pond Machine Tool Co., Plainfield, N. J.



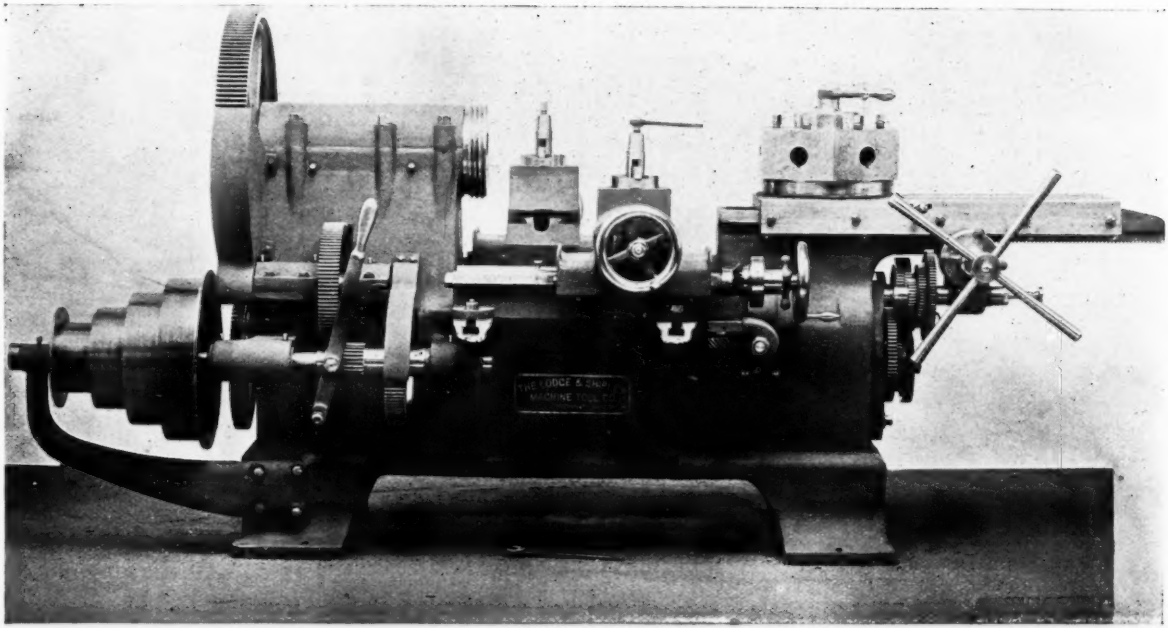
DOUBLE VERTICAL SPINDLE MILLING MACHINE.

Pratt & Whitney Co., Hartford, Conn.



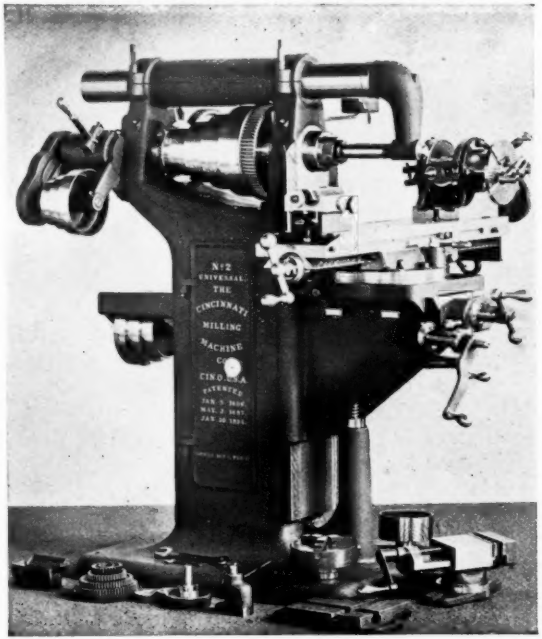
HARTNESS PATENT FLAT-TURRET LATHE.

Jones & Lamson Machine Co., Springfield, Vt.

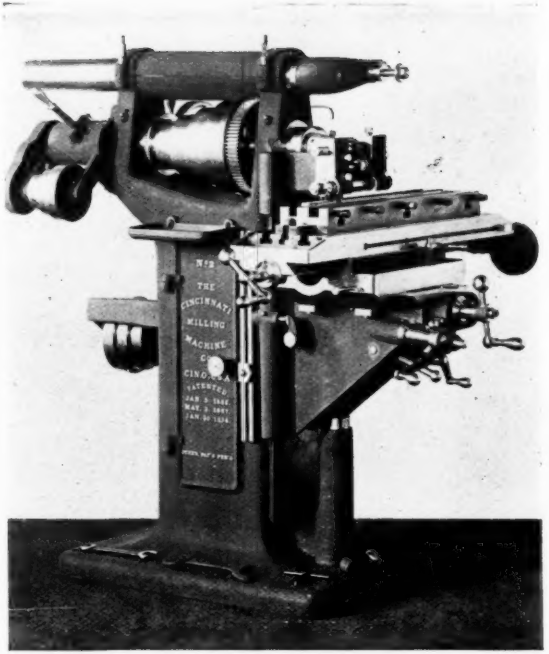


30" DOUBLE-SADDLE TURRET LATHE.

Two Independent Tool posts and Six Hole Turret; Independent Feeds. Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

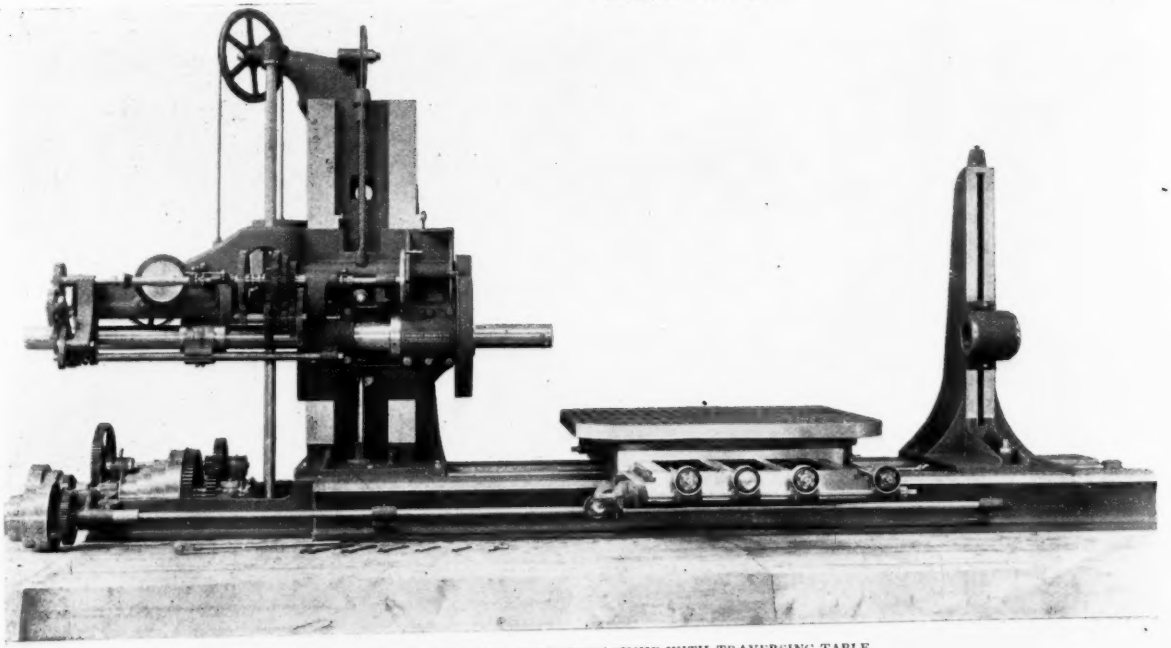


UNIVERSAL MILLING MACHINE.



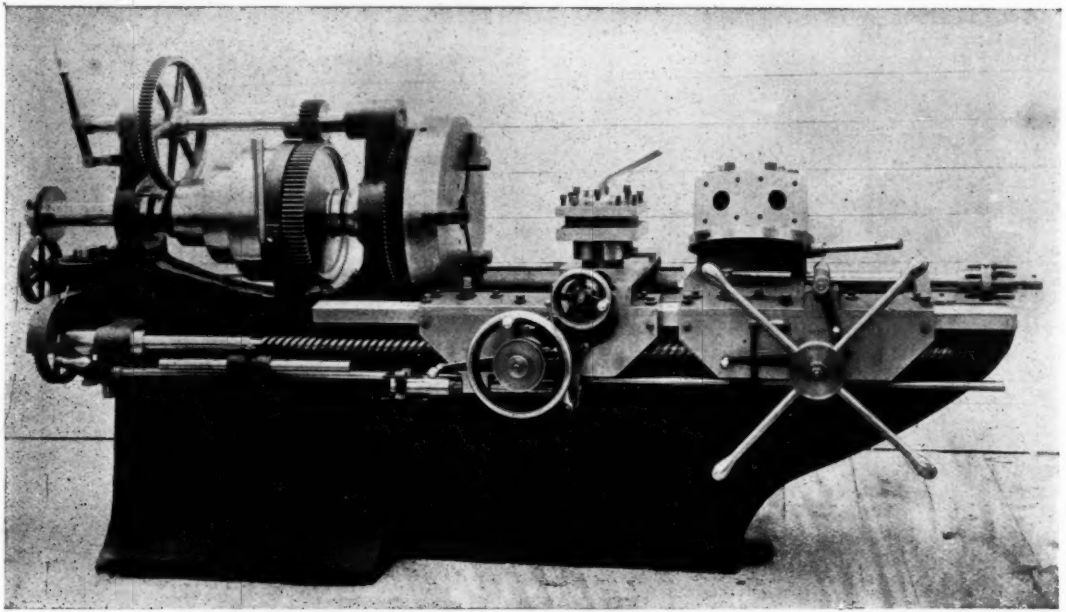
PLAIN MILLING MACHINE WITH AUTOMATIC FEEDS IN ALL DIRECTIONS.

Cincinnati Milling Machine Co , Cincinnati, Ohio.



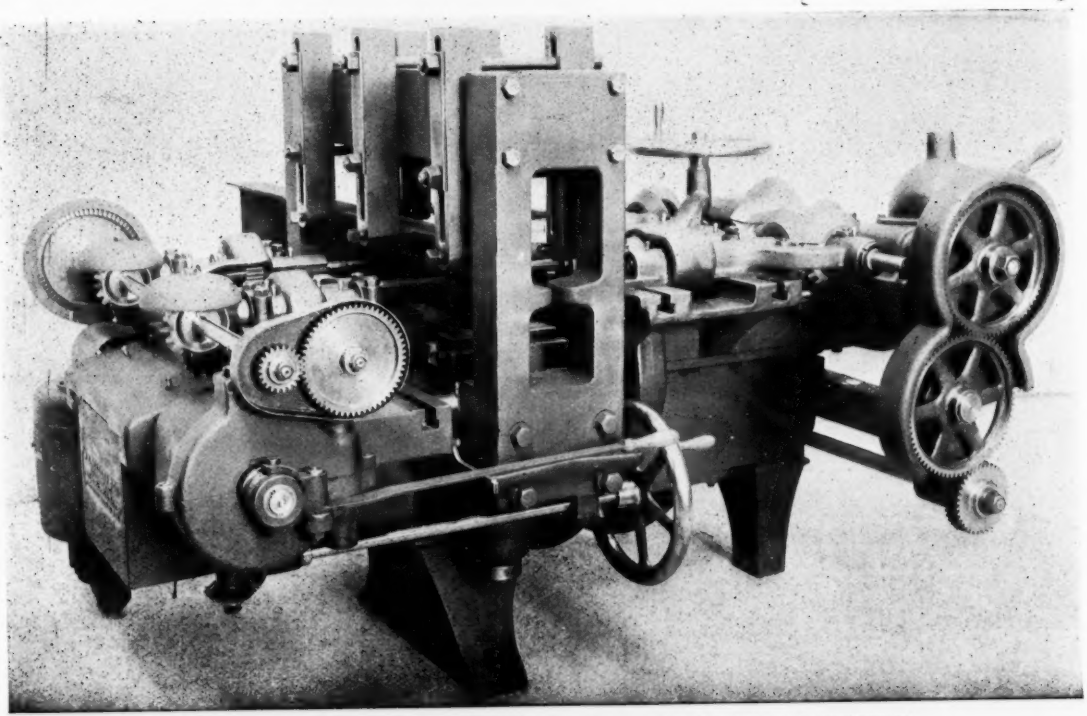
SCREW-CUTTING UNIVERSAL MILLING MACHINE WITH TRAVERSING TABLE.

Bement, Miles & Co., Philadelphia, Pa.



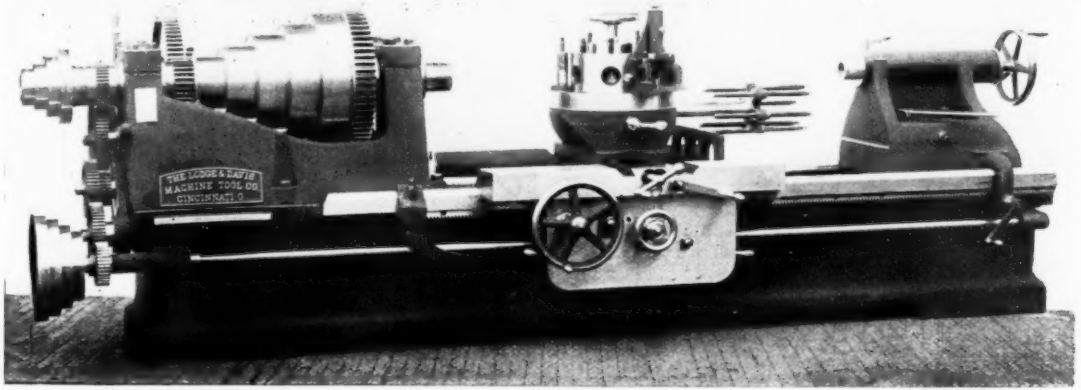
STANDARD FRICTION-HEAD TURRET LATHE.

Gisholt Machine Co., Madison, Wis.

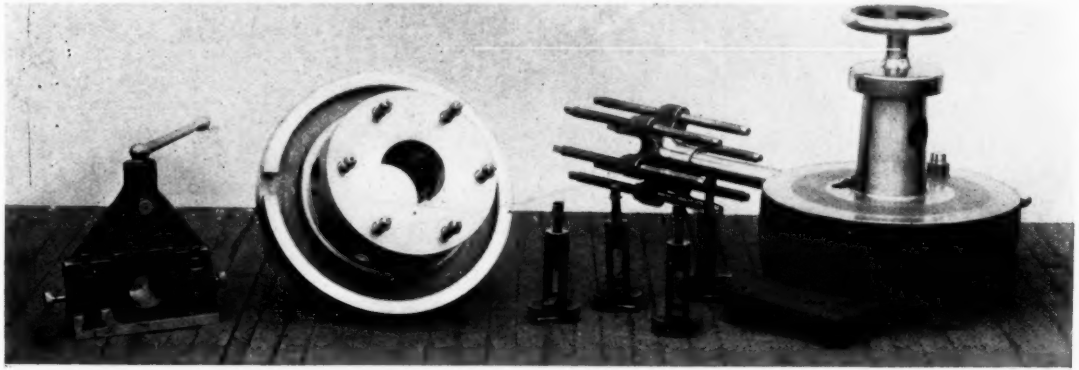


FIVE-SPINDLE HORIZONTAL RAIL-DRILLING MACHINE, FOR ELECTRIC RAILWAY CONSTRUCTION.

Wm. Sellers & Co., Incorporated, Philadelphia, Pa.



36" LATHE FITTED WITH COMBINATION RING TURRET, FOR MAKING STUDS, BOLTS, ETC. UP TO 3" DIAMETER.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.



DETAILS OF TURRET MOUNTED ON LATHE ABOVE.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.

THE IMPORTANT FUTURE OF PRODUCER-GAS.

By A. Humboldt Sexton.

THAT producer-gas has failed to take the position in the world of manufactures which those familiar with its advantages think that it deserves can hardly be denied. It is universally used for firing open-hearth steel furnaces, and in a few other operations where high temperatures are required it has to some extent come into use; but in the majority of our manufactures it is very little used, and for steam-raising and similar purposes its value has hardly been recognized. Yet for many purposes—probably for most—it has very decided advantages over solid fuel, both as regards convenience and economy. That the importance of these advantages has not been fully realized is evident, and for this there must be some good reason. Is it that the manifest advantages of gaseous fuel are accompanied by less obvious disadvantages, which to ordinary fuel-users more than counterbalance them? And, if so, are these disadvantages inherent in the fuel itself, or are they due to the use of unsuitable and defective forms of plant? Or is the neglect due merely to innate conservatism which makes most people loth to change the methods of work to which they have been accustomed?

That there are certain disadvantages attending the use of gaseous fuel may be admitted, but they are so few and unimportant that they cannot weigh against the many advantages; the writer feels, therefore, that the small progress which has been made in the use of gaseous fuel has been very largely due to the unsuitability of much of the plant that has been employed,—for, unfortunately, very few of the gas-producers at present in use allow anything like a full realization of the convenience and economy of gas-firing.

On studying the various patents which have been taken out for gas-producers, one is at first appalled by their number; but this feeling is soon replaced by one of wonder at the extraordinary lack of originality shown by the patentees, and at the evident ignorance of most of them of the principles on which gas-production is based. Most inventors seem to content themselves with merely modifying or improving (?) in details forms already in use, while but few go back to first principles, study the nature of the various operations, and consider how best these may be applied to the case in hand. Too often also the attempt is made to make a producer which will give gas suitable for all purposes rather than for one special purpose, regardless of the fact that what is best for one purpose may be worst for another, and that it is

impossible to design any form of plant which will be equally good under all conditions.

That a plant may be successful, it is, above all, essential that it should be economical in working. The first cost is of little moment since it is incurred once for all; but the cost of up-keep and repairs must be low, and the less labor required the better. The gas produced must be as rich as possible in combustible constituents, it must be suitable for the purposes for which it is required, and the expenditure of energy in the conversion of the solid fuel into gas must be kept at the lowest possible point. This can be done only by minimizing all sources of heat loss.

The theory of the manufacture of producer-gas is very simple, but a brief consideration of it may be useful. The simplest possible form of producer is undoubtedly the early Siemens type, which for a long time was largely used, and which even now is not quite extinct. It consisted of a rectangular chamber of fire-brick provided at the bottom with fire-bars and at the top with a tube for carrying off the gas and a hopper for charging the fuel. The grate was open to the air, and the draught was produced by a chimney.

Assume such a producer at work, using coke or charcoal as fuel, and no steam being used. The air entering would burn the carbon to carbon monoxid and carbon dioxid, and the latter, if the producer were working perfectly, would be decomposed by the hot charcoal, forming carbon monoxid, so that the escaping gas would consist only of carbon monoxid and nitrogen, and would contain 34.7 per cent. of the former. Such a gas would have a very low calorific power, and its production would be extremely wasteful, as about one-third of the heat which the solid fuel was capable of giving would be evolved in the producer, and thus lost for all practical purposes. There is considerable misapprehension as to the nature of this loss of heat in the production of producer-gas. It is often spoken of as if it were heat absorbed or rendered latent, as is the case when water is boiled into steam. It is, however, quite different; heat is not absorbed, but evolved; only, it is evolved in the producer, where it is not wanted, instead of in the furnace, where it is wanted. Therefore it cannot be used to advantage.

In order to secure economical production, the gas must be enriched, and at the same time the evolution of heat in the producer must be reduced to the lowest point. Both these objects are secured by the use of steam. When steam comes in contact with hot carbon, it is decomposed, and yields equal volumes of carbon monoxid and hydrogen. The amount of carbon monoxid produced is the same as if the carbon were burned by air, but, instead of being mixed with about twice its bulk of inert and incombustible nitrogen, it is mixed

with its own volume of combustible, strongly-heating hydrogen ; if it were possible to use all steam and no air, the gas would be what is commonly called water-gas. The decomposition of the steam, however, absorbs a very large quantity of heat, and, therefore, if too much be blown in, the action would stop, or, at any rate, be seriously modified. The heat is absorbed in producing these combustible gases, which, by burning in the furnace, give out the heat again, thus serving as carriers of heat from the producer, where it is not required, to the furnace.

The amount of steam that can be used is limited, for, owing to the absorption of heat, if too much be blown in, the action will not go on satisfactorily. If too much steam be used without abundance of air, the cooling will be so great as to stop the action altogether ; if sufficient air be supplied at the same time, the cooling will be less complete, but a large quantity of carbon dioxid will be formed, and much steam will pass through undecomposed, thus carrying away a large quantity of heat. By the judicious use of steam the loss of heat in the producer may be reduced to about fifteen per cent. of the heating power of the fuel.

The gas may be further enriched by the use of coal, instead of charcoal or coke, as assumed above. The coal is thus distilled, and the products of distillation mix with the producer-gas, the amount of added gas varying from a trace with anthracites up to nearly ten per cent. with very bituminous coals.

The sources of loss of heat in gas-production are due :

(1) To undue evolution of heat in the producer by formation of carbon dioxid ;

(2) To loss of heat from the producer itself,—

(a) Carried away by the gases,

(b) Lost by radiation,

(c) Carried out in the ashes,

(d) Used in distilling the coal.

As it is necessary to keep up the temperature of the producer to the point at which combustion can take place, the greater the amount of heat lost, the smaller is the quantity of steam which can be used. It is obvious that the losses can never be reduced to nothing ; if they could, once the producer was started, the heating power of the gas would be equal to that of the solid fuel from which it was produced. This is impossible, and so the heating power of the gas is always less than that of the solid fuel by an amount which will be greater, the greater the loss of heat in the producer. When carbon monoxid is being produced, the evolution of heat in the producer, as remarked, is about one-third of that which the solid carbon would give ; but, imme-

diately carbon dioxid is produced, the loss becomes very much larger, being, of course, evolution in the wrong place. Not only does it do this, but it impoverishes the gas, robs it of its chief combustible constituent, and increases the quantity of inert nitrogen. Carbon dioxid occupies the same volume as a quantity of carbon monoxid containing the same amount of carbon; but, as it contains twice the amount of oxygen, its production adds twice the amount of nitrogen to the gas. As already remarked, if, in a producer fed with charcoal, all the carbon were burned to carbon monoxid, the producer-gas would contain:

Carbon monoxid	34.7
Nitrogen	65.3
	100.0

If, however, one-third of the carbon were burned to carbon dioxid, the composition would be:

Carbon monoxid	19
Carbon dioxid	9.5
Nitrogen	71.5
	100.0

This amount of carbon dioxid is frequently present in producer-gas. Under these circumstances the heat evolved in the producer, and therefore lost, would be about fifty per cent. of that which the solid carbon could give, if completely burned.

It is obvious, therefore, that in gas-production it is of the very utmost importance to prevent the formation of carbon dioxid, and no producer can be efficient which allows more than a trace of this to be produced.

The amount of heat carried away by the hot gas leaving the producer is very large, and, without an exceptionally high temperature, may reach ten per cent. of the heat which the fuel can evolve, or one-third of that given off in the producer when no steam is used; if steam is escaping with the gas, the amount may be very much more. The heat carried away is in most cases lost, as the gases cool before entering the furnace, and, if regenerators are used, nothing is gained by sending in the gas hot. Obviously, therefore, the gas should be cooled to the lowest possible temperature before it leaves the producer, and this can best be done by passing the gas through a thick layer of fuel, to which it can give up its heat.

The loss of heat by radiation is also large; the larger the radiating surface in proportion to the heat evolved, the greater will be the loss.

The loss by the fall of hot ashes is small, but in bar-bottom pro-

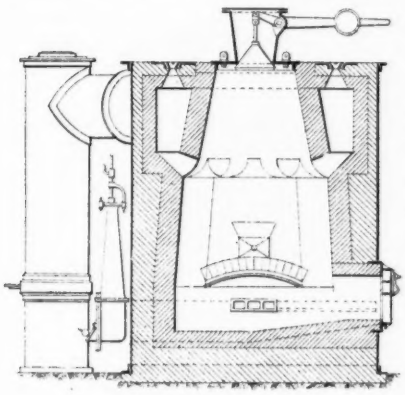
ducers there may be considerable loss by the fall of unconsumed fuel through the bars.

The heat absorbed by distillation of the coal is small, and may be neglected in the comparison between solid and gaseous fuels, because, even when coal is burned on a grate, the gas distills out before it burns. The gas-producers at present in use fall into two chief groups,—those used with a natural draught, and those used with a blast.

(1) Producers worked by natural draught. Of these the first Siemens producer may be taken as a type. The draught was obtained by passing the gas through a long overhead cooling tube. The cold gas in the vertical portion farthest from the producer, being heavier than the hot gas in the portion near the producer, acted as a siphon, and produced a current. The grate-bars were open to the air, so but little steam could be used. The gas, therefore, was poor, and, as the layer of fuel was thin, often contained a considerable quantity of carbon-dioxid. This type of producer has now been almost completely abandoned. It was not efficient, and the fuel consumption was only about fifteen pounds per square foot of grate area per hour.

(2) Producers worked by draught. Of these there are three distinct types.

(a) Bar-bottom producers. In these the fuel rests on fire bars beneath which the air is blown. They vary much in form, but differ from the class already described in the fact that the hearth is closed. They are usually of small size, and the consumption of fuel is small. This type of producer has been almost entirely abandoned in Great Britain, except for small installations, as it is much less efficient than other types. For small plants producers of this form are handy, as they are easily managed. (b) Solid-bottom producers. In these there are no grate-bars, but the ashes rest on the solid bottom of the producer, and the air and steam are blown into the center of the mass. These are the most popular producers in Great Britain, the best known form being the Wilson. A much greater pressure of steam can be used with this class

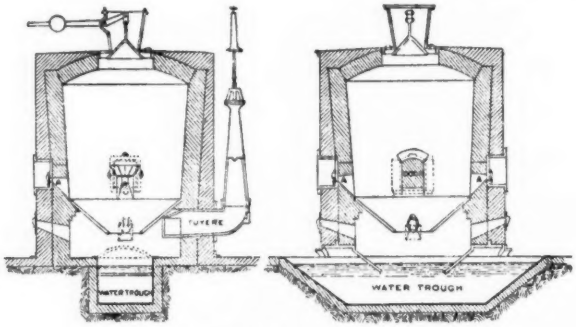


THE WILSON PRODUCER.

of producer, and a more rapid combustion can, therefore, be obtained, many producers burning as much as forty pounds of fuel per square foot of bottom per hour. They can be made of considerable height, and, owing to the high temperature that can be obtained, the gas contains very little carbon dioxid. They may be built separate or in block, the latter being usually the most economical.

One objection to most solid-bottom producers is the necessity for stopping periodically for the removal of the ashes. This difficulty has been overcome in the Wilson Automatic, Taylor revolving bottom, and some other producers.

(c) Water-bottom producers. These are solid-bottom producers in which the ashes are received in a vessel of water, the sides of the producer being carried down into the water far enough to form a water seal, and prevent the escape of gas, and to allow the withdrawal of the ashes below. The lower portion of the producer is usually made conical, and may be solid, or in the form of a hanging grate. The air and steam may be blown into the center of the fuel by means of a steam pipe, but usually they are supplied to a space between the annular grate and the casing, so that they pass up through the hot ashes. These producers are efficient, and are rapidly coming into use. The heat of the ashes is utilized in evaporating the water, and they are easily cleaned. The best known producer of this type is the Dawson.



THE DAWSON PRODUCER.

All the producers described are usually made low, being rarely more than twelve to sixteen feet in height. The gases, therefore, leave at a high temperature, and very frequently contain carbon dioxid in considerable quantity. The only way in which the heat carried off by the gases can be saved is, as already remarked, that of making the column of fuel higher; and the only way to prevent the formation of carbon

dioxid is to increase the zone in which the temperature is high enough to ensure its decomposition by the hot carbon.

When these changes have been made, the producer will approach very near to a blast furnace in type.

The blast furnace is, in many respects, an ideal gas-producer. The gas from an ordinary iron-smelting blast-furnace contains a large quantity of carbon dioxid produced by the reduction of the iron oxid; but even then it compares favorably with some producer-gases, and can be used for all purposes for which gaseous fuel is required, including steel-making in open-hearth furnaces and driving gas engines. If there were no reducing reactions to take place, the gas would contain no carbon dioxid. In ordinary producers the ashes are drawn out solid; in a blast-furnace producer they are melted and tapped out. The fluxing of the ashes might necessitate the addition of a small quantity of limestone, but the carbon dioxid from it would probably be decomposed at the temperature at which it was separated. With a blast furnace the fuel-consumption, and, therefore, the gas-production, is very much larger than in ordinary producers. A blast furnace of moderate size will consume two hundred pounds of coal per square foot of bottom per hour, reducing the sources of loss to a minimum.

The writer is convinced that it is in the direction of approach to the blast-furnace type of producer that we must look for future developments in gas-production; and, curiously enough, this would be reverting to one of the very earliest forms,—that of Ebelman.*

Coal is now almost always used in gas-producers, and, when it is subjected to destructive distillation, a large quantity of tarry matter is produced, which has sometimes proved troublesome; therefore, many attempts have been made to destroy or remove it.

When open producers were used with an overhead cooling tube, much of the tar was condensed in this; but, now that this has been abandoned, much of the tar is carried forward with the gas.

In the Wilson and some other producers the gas distilled from the coal is made to pass through the incandescent fuel, and the tarry matter is thus broken up into permanent gases and solid carbon. If the tar is to be removed, it seems more rational to condense it, and thus recover it and any ammonia that may be present.

Whether the tar should be removed or left depends upon the conditions under which the gas is to be used. There can be no doubt that the removal of the tarry matter reduces the heating power of the gas, but by how much it is quite impossible to say, as the amount of

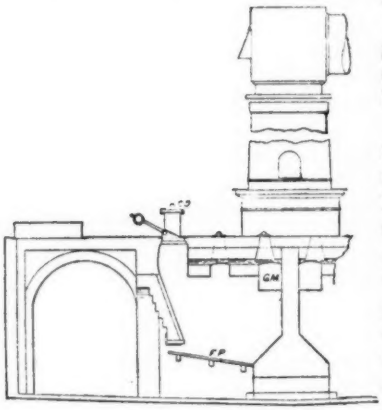
* Mr. Ormiston of Glasgow published a pamphlet a few years ago, calling attention to the blast furnace as a gas producer.

tar which deposits and the amount which is carried forward by the gas are uncertain. Probably the reduction of heating power may be taken as being about ten per cent., though some workers have placed it as high as twenty per cent., or even more.

When the gases are passed through brick-lined or underground flues, so that they do not cool, there is still a deposition of tarry matter, which has to be burned out each week end; but the bulk of the tar is, no doubt, carried forward into the regenerators, there it is to a large extent decomposed with the deposition of solid carbon, which will be burned when the gases are reversed.

When used in regenerators, therefore, probably the tarry matter adds but little to the heating power of the gas, and may be safely removed and utilized in other ways. When the gas is to be used for boiler-firing and similar purposes without regenerators, the removal of the tar is, no doubt, very disadvantageous. If the producers are so placed that the flues are short, there will be very little condensation, and the tarry matter will be carried forward, adding to the heating power of the gas, and at the same time—what is of far more importance for this purpose—adding to the luminosity, and, therefore, to the radiative power, of the flame. It is difficult to conceive a more inefficient way of securing steam than the use of tar-free gas burning with a non-luminous flame under ordinary boilers.

For such purposes as reverberatory furnace and boiler-firing, where a radiative flame is required, it seems best to send the hot tar-laden gas direct to the furnace, and use an air regenerator for heating the air.



SIEMENS PRODUCER.

For use in gas engines the gas must be free from tar and dust, and should, therefore, be well washed.

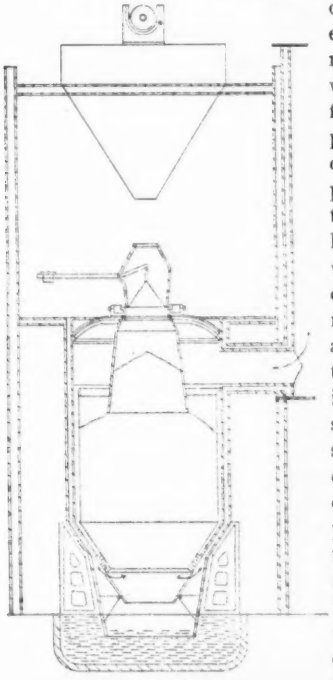
Among recent suggestions for the use of gaseous fuel the furnace and producer of Mr. F. Siemens deserves notice. In this system the air only is heated by passage through a regenerator. The products of combustion are divided. One half is sent through the regenerator, the other half being sent, together with some air, into the producer. The carbon

dioxid in the products of combustion is reduced to carbon monoxid, and the gases pass to the furnace at a very high temperature. These furnaces are being somewhat extensively used for reheating and similar purposes.

The writer thinks it would probably be more satisfactory, if four regenerators were used as usual, the air being heated in one and steam and air for the producer being heated in the other. In that way gas could be economically supplied at a very high temperature direct from the producer to the furnace.

Another method of making producer-gas has recently come to the front, and promises to be largely used in the future. The method was invented and patented some years ago by Dr. L. Mond, and has been recently taken up by Mr. J. H. Darby. The gas obtained by this process is very different from ordinary producer-gas, and may, for convenience, be called Mond gas.

The object of Mr. Mond was to obtain the largest possible quantity of ammonia, and in this he was eminently successful. Mr. Darby now obtains a gas of good quality, which has been successfully used for steel-melting and other purposes. The principle of the process is simply to blow in the largest possible quantity of steam, and so to produce a large amount of free hydrogen, under the influence of which, probably in the nascent condition, a large quantity of the nitrogen of the fuel is evolved as ammonia. The gas-producer is of the water-bottom type, with a conical grate through which the air and steam are blown. The amount of steam supplied is about two and one-half tons for each ton of coal consumed, and necessarily a large proportion of this passes through undecomposed. The gas leaves the producer at about 500°C., and is passed through cooling tubes, where a good deal of the water is condensed; then through an agitator, where it is mixed with cold



MOND GAS PRODUCER.

water ; then up a lead-lined tower, where it meets a descending rain of sulphuric acid ; then up another tower, where it is washed with cold water ; and then to the furnaces, or engines, where it is to be used. The yield of gas from a common slack containing eleven per cent. of ash is about one hundred thousand cubic feet per ton, and its average composition by volume is :

Carbon dioxid	17.1
" monoxid	11.0
Olefines	.4
Methane	1.8
Hydrogen	27.2
Nitrogen	42.5
	100.0
Total combustible gas	40.4

The amount of ammonium sulphate recovered is about ninety pounds for each ton of coal consumed, the coal containing about 1.5 per cent. of nitrogen. Mond gas has been successfully used for various purposes, among others for driving gas engines, for which its freedom from dust and tar, and its high calorific power, render it specially suitable. While the first cost of the plant is high, the large amount of ammonium sulphate recovered makes it a profitable method of gas-making.

The writer believes that there is a great future before gaseous fuel, and that, ere long, it will to a large extent supersede solid fuel for many purposes with great advantage, both as to economy and efficiency, and that with this development the gas engine will to a large extent take the place of the steam engine as a source of energy.

BRITISH RAILWAY STOCKS AS DESIRABLE INVESTMENTS.

By William J. Stevens.

IN the ENGINEERING MAGAZINE for May last an able article appeared from the pen of Mr. Thomas F. Woodlock, entitled: "Are English Railroads Good Investments?" The conclusion he arrives at is not favorable to this class of securities at all. But it appears to the present writer that he has based his adverse view of the merits of British railway stocks too rigidly on the set of figures which he produces, and which, on a cursory view, may seem to justify his apprehensions. The basis of Mr. Woodlock's criticism is revealed in the following quotation from the article referred to: "The first thing that strikes one on investigating the statistics of the railroads is that in the last few years they have absorbed a very large amount of capital, without a corresponding increase in mileage."

"The second thing—even more striking—is that this increase in capital has not produced a proportionate increase in net revenue. The third (necessary consequence of the preceding) is that the average return on British railroad capital shows a tendency to decrease. These are three very important facts bearing on the character of this capital as an investment."

The points indicated above are brought out carefully by the statistics contained in the article. But, while admitting that all the above contentions are true, they do not prove that there is anything inherently unsound in the position of British railways. The arguments which Mr. Woodlock so skilfully supports by his figures all turn on the important phrase in the above quotation from his article—"the last few years." It would be nothing less than madness to attempt to prove that the position of the railways of the United Kingdom has not very seriously deteriorated within the last few years. Gross revenue has certainly increased, but expenses have increased more rapidly, and dividends have fallen "in the last few years;" yet the real position of the railways is good. Railways, like every other branch of industry, are liable to fluctuations in their fortunes, and these fluctuations follow very closely the course of trade in the United Kingdom. When trade is good, traffic is good, net revenue increases, and the net return on the capital increases. When trade is bad, traffic does not increase to the same extent (in fact, does not increase at all, but really declines, if allowance be made for the increased mileage), expenses do not decline

in any appreciable proportion, and dividends consequently suffer. But such changes are entirely beyond the management of the railways, and are the outcome of extraneous influences, by which it is hardly just to acquit or condemn them *qua* railways. Because they suffer from the inevitable fluctuations in trade, does it follow that their merits as investments are to be gaged thereby? If the trade of any country were steadily declining without hope of recovery, that would, of course, render the railway stocks undesirable investments; but in that respect they would suffer only in common with all industrial securities.

Fortunately, during the last twelve months, the trade of the United Kingdom has taken a distinct turn for the better, and the railways are showing large increases in their traffic. For the second half of 1895 they showed important increases in their dividends, which improvement, according to previous experience, may be expected to continue for the next few years. Mr. Woodlock's figures, be it remembered, showed the position only to the end of 1894, that being the latest period for which the board of trade statistics relating to the railways of the United Kingdom are as yet available. It is unfortunate that he did not examine the results of British railways since the end of 1894. It may be well to recall the fact that both 1893 and 1894 were exceptionally bad years, on account of coal strikes without parallel in the industrial history of the United Kingdom. In the second half of 1893 a great strike took place in the Midlands, mainly as a result of which five important companies alone lost £1,738,000 (say, $8,690,000), nearly all of which was net loss, owing to inability to reduce expenses, the price of coal being very high. In the following year, from July to October, a strike occurred among the coal miners of Scotland, which, though not so serious as the English strike of 1893, nevertheless played havoc with the gross earnings of the Scotch railways. Bearing these facts in mind, can it be matter for surprise that the net return on the capital of British railways in 1893 and 1894 was, with one or two exceptions, the lowest in their history? And it is on the results of the later of these two years that Mr. Woodlock has based his adverse judgment of British railways as investments!

From 1885 to 1889, as Mr. Woodlock showed, the average return on the whole capital of British railways increased from 4.13 per cent. to 4.32 per cent., while the average dividend on the ordinary capital increased from 4.04 per cent. to 4.66 per cent. That was a time of improving trade, and presumably, if Mr. Woodlock had applied his test of the merits of these stocks in 1890 or 1891, instead of in 1896, he would have come to a favorable conclusion. From 1889 to 1894 the average return on the whole capital declined from 4.32 per cent. to 3.87 per cent., and the average dividend on the ordinary stocks

from 4.66 per cent. to 3.80 per cent. That was the outcome of a period of declining trade, with two years of unprecedentedly disastrous strikes at the end of it.

What has happened since in 1894? Well, for the first half of 1895 trade did not show any improvement, while passenger traffic was injuriously affected by a very severe and prolonged frost. But in the second half of 1895 traffic showed an all-round improvement, expenses did not show a relative increase, and the net receipts improved to such an extent as to enable the majority of companies to pay considerably increased dividends, as compared with the second half of 1894. Subjoined is a comparison of the distributions for the second half years of 1894 and 1895 as regards the twelve principal English and Scotch railways, to show how general, and in some cases how large, the improvement in dividends was:

Company.	Dividend. per cent. per annum. 2nd half, 1894.	Dividend. per cent. per annum. 2nd half, 1895.	Increase.
Caledonian	3¼	5½	2¼
Great Eastern	2¼	4	1¾
Great Northern	4	4¾	¾
Great Western	6	7	1
Lancashire & Yorkshire	4½	5¼	¾
London & No. Western	6¾	7½	¾
London & So. Western	7½	7¾	¼
Manchester, Sheffield & Lincoln	1½	1¾	¼
Midland	5¾	6¼	½
North Eastern	6¾	6¾	—
North British (Preferred)	1½	3	1½
North British (Deferred)	nil.	1¼	1¼
South Eastern	5¾	6	¼

During the current year the improvement in gross traffic has continued, and there is every promise of further improvement in the dividends. The *Railway Times* records the increase of the thirty-three principal railways for the twenty-two weeks to the end of May as £2,322,000 (say, $11,610,000), representing an increase over the 1894 figures of nearly 8 per cent., though the addition to the mileage was less than three-fourths of one per cent.

There is every reason to hope that a large proportion of the increase in gross receipts recently recorded will be retained as an addition to the net revenue, and that a material increase in dividends will take place during the current year. The general experience in the second half of last year warrants this belief, while the improvement will have all the greater effect on dividends, as the capital expenditure has lately been on a much diminished scale. The effect of all this will be, of course, to materially improve the average return on the

whole capital of the railways of the United Kingdom, which, as Mr. Woodlock showed, had fallen in 1894 to only 3.87 per cent. compared with 4.13 per cent. in 1885.

One important point should be called attention to,—the effect of merely nominal additions to capital in increasing the apparent capitalization per mile, and also in reducing the apparent net yield on the whole capital. From 1885 to 1894 the total capital of the railways of the United Kingdom increased from £815,858,000 (say, $4,079,290,000) to £985,387,000 (say, $4,926,935,000). But in the latter figure is included £81,044,000 (say, $405,220,000) representing these nominal additions. A very large proportion of this nominal increase arose in the ten years 1885-1894. Mr. Woodlock himself puts it at $450,000,000 (page 241, vol. xi). This is obviously an overstatement of the case ; I think $300,000,000 would be nearer the mark.

Observe the effect of this. If nominal additions be included, as they are in Mr. Woodlock's figures, the amount of capital per mile of railway is shown to have increased from $212,605 in 1885 to $235,650 in 1894. If the proper course of excluding the nominal additions be followed, then the amount of capital per mile is shown to have increased by only $8,745,—to $221,350 per mile. Similarly the net return on the capital is calculated in 1894 on the sum thus swollen by nominal creations of capital, and on this basis the apparent decline in the net yield was from 4.13 per cent. for the year 1885 to 3.87 per cent. for 1894, whereas, if due allowance be made for the "watering" of the capital in the interval, the return for the year 1894 would really be over 4 per cent.

The increase in the mileage between 1885 and 1894 was only 1,739. But in 1885, out of a total mileage of 19,169, only 10,446 were of "double or more lines," as against 11,392 in 1894, out of a total mileage of 20,908. Thirteen leading companies which, as recently as 1888, had among them 138 miles with three lines and 351 miles with four or more lines, had in 1894 increased their three-lines track to 146 miles and their four-or-more-lines-track to 504. These are developments of their existing systems which entail large outlays of capital, and which add immensely to their facilities for handling traffic ; but they are not disclosed in the mere statement of their longitudinal mileage.

There is another important consideration bearing on the question of the net return on the capital invested in British railways. To maintain their ordinary dividends at the rates then paid, it is not necessary for them to maintain the same overhead return on their whole capital now as ten years ago, or even five years ago. The rates at

which they have been able to raise new capital have constantly been falling, and in a most marked way has this been the case since 1889. The average cost to the leading railways of the money they have raised since 1889 does not appreciably exceed 3¼ per cent., and at the present time is under 3 per cent., while ten or twelve years ago the average cost of new capital would have been about 4 per cent. Since 1889 the railways have raised, in all, about one hundred million pounds sterling, and the difference between 3½ and 4 per cent. on this sum amounts to the very important figure of £750,000 (say, $3,750,000) per annum. This sum represents nearly one-tenth of one per cent. on the total capital outstanding.

If the results had been brought up to the end of 1895, and then a comparison made with 1885, the position of the British railways would have looked much more cheerful, as the following table showing the dividends paid on the principal ordinary stocks for 1885 and for 1895 evidences:

Stock.	Dividend p. c. for 1885.	Dividend p. c. for 1895.	Increase or decrease.
Caledonian	4	5	+ 1
Great Eastern	2	2⅜	+ ⅜
Great Northern	4½	3⅝	— ⅞
Great Western	5	5⅛	+ ⅛
Lancashire & Yorkshire	3¼	4½	+ 1¼
London & North Western	6½	6⅜	— ⅛
London & South Western	5	6⅛	+ 1⅛
London, Brighton & So. Coast	4⅜	6	+ 1⅝
Midland	5⅛	5⅛	—
North British	2½	3⅝	+ 1⅛
North Eastern	6	5⅜	— ⅜
South Eastern	4⅝	4⅛	— ½

There is no evidence in the above table of any general deterioration in the position of British railways, for the increases largely outweigh the decreases. Where the latter are shown, it should further be noted that the increase in gross receipts already recorded for 1896 leaves no room for doubt that they will pay higher dividends for the current year than for 1885, which, by the way, must be admitted to have been anything but a good year.

But the improvement in the rates of distribution on the ordinary stocks in the second half of last year, and the continued increase in gross receipts since, are very reasonably regarded as only the beginning of a period of reviving dividends, following as previously a period of declining dividends. Owing to the coal strikes in 1893 and 1894, to which reference has been made, the period of falling profits has been prolonged for nearly six years,—namely, from 1889 to the middle of 1895.

One most encouraging point about British railways is that they

have, during the past five or six years of declining trade, met and overcome an exceptional increase in certain items of working expenditure. The principal of these items have been "wages" and "rates and taxes." Both have, from various causes, increased rapidly during the last ten years. Now the increase has been arrested, so that increasing gross receipts will not be eaten up, as in the past, by increased expenses, but will have due effect on net receipts and consequently on dividends. Mr. Woodlock in his article finds fault with the companies because, since 1889, nearly the whole increase in expenses has been in what he terms the "compulsory" expenses, while the expenses connected with the maintenance of permanent way and rolling stock, described as "optional" expenditure, have increased only very slightly. From this he draws the conclusion that "the railroads seem to have been compelled to spend so much more money to run their trains that they economized on the repairs and maintenance of their property." This is a serious charge; the more so because Mr. Woodlock goes on to draw the inference that capital is being made to bear the burden of this false economy in revenue charges for maintenance. But what are the grounds for the charge? Of a very negative character indeed, when examined closely. Compared with 1885, the maintenance charges showed a reduction of 0.5 of a cent, and, compared with 1889, an increase of 0.3 of a cent, per train mile, in 1894. The lessened cost of materials would alone justify the decrease, while it is a rule, even among the best companies, to be more liberal in their maintenance expenditure in good years than in poor ones. The average cost of rails in Great Britain fell over $2½ per ton between 1889 and 1894. As for the increase in other expenses,—*i. e.*, "compulsory" charges which in 1889 and 1894 amounted, according to Mr. Woodlock, to 3.5 cents per train mile, of which 1.5 cents was in motive power and 2.0 cents in "other" expenses,—the explanations are provided by himself. They are the increased cost of labor, the higher price of coal (the latter included in motive power), and, we may add, the addition to rates and taxes. The principal increase in wages was in the traffic department, included in "other" expenses. The large addition to the sum thus expended accounts for a good deal of the additional expenditure per train mile, and, though wages in the maintenance departments have increased relatively quite as much as train mileage, they do not represent the same important addition to the rate per train mile as in traffic expenses, for the reason explained below. This will be illustrated by the following, showing the wages paid in the "maintenance" departments of the four leading lines in 1889 and 1895, and the corresponding sums paid as wages in the traffic department:

WAGES INCLUDED IN MAINTENANCE OF WAY; LOCOMOTIVE, CARRIAGE, AND WAGON REPAIRS.

Company.	1889.	1895.	Increase.	Per cent.
	£	£	£	
Great Western	1,016,216	1,230,803	214,587	21.1
London & No. Western	1,155,116	1,286,752	131,636	11.4
Midland	1,091,298	1,299,162	207,864	19.0
North Eastern	957,059	1,089,959	132,900	13.9
Total £	4,219,689	4,906,676	686,987	16.3

WAGES IN TRAFFIC DEPARTMENT.

Company.	1889.	1895.	Increase.	Per cent.
Great Western	858,861	1,012,640	153,779	17.9
London & No. Western	1,481,760	1,722,226	240,466	16.2
Midland	1,223,210	1,622,440	399,230	32.6
North Eastern	765,186	1,020,543	255,357	33.4
Total £	4,329,017	5,377,849	1,048,832	24.2

It will thus be seen that wages in the "maintenance" departments have increased by 16 per cent. In the traffic department they have increased by £1,048,800 (say, $5,244,000), or 24.2 per cent. since 1889. The reason for the discrepancy is this. During recent years there has been a strong movement in the direction of shorter hours, and there has been legislation since 1889 to compel this in certain circumstances. This has affected the out-door staff, such as signalmen, guards, porters, shunters, etc., to a considerably larger extent than the men—most of them skilled artisans—employed in the repairing-shops, who already had regular hours, with payment for overtime; and the increase in the wages paid in the maintenance departments represents little more than the increase in work done. The whole burden of increased rates and taxes, moreover, has been included in the increase in "other" expenses referred to. Between 1889 and 1894 the increase over all the lines averaged well over 25 per cent., the addition alone amounting to nearly £600,000 (say, $3,000,000). The cost of coal rose as well, and, as both these items are included in the "compulsory" expenses, while having no counterpart in the maintenance or "optional" charges, is it at all strange, after all, that the latter have not increased so fast as the general expenses of railway working?

That the railways of Great Britain have withstood so well the period of comparatively stationary gross receipts, increasing expenses, and new capital burdens is the best possible evidence of their financial stability. Now that the prospect has changed and the revenue of the railways is increasing, they are likely to get something like an adequate

return on the capital outlay incurred during recent adverse years. This capital outlay has fully prepared them for the efficient handling of a much larger traffic than that of late years, and there can be no doubt that a very large share of the increased receipts will go to improve dividends. New capital burdens are not so large this year as they have been for a long time,—a point which is of the utmost significance at the present juncture.

What wonder that with the vista of a period of improving dividends which has opened up after about six years of declining distributions, investors have made a run on the ordinary stocks of British railways with the result that prices have, during the present year, very materially improved? The high prices of all investment securities of a good class had already, in recent years, maintained the ordinary stocks at prices on which the yield, on basis of the declining dividends, has been only 3 to 3½, and, in the instance of some of the more speculative stocks, the return was even less than the former of these rates. The great dearth of investments which offer to the British investor any prospect of improving results, without unreasonable risks, has no doubt served to accentuate the demand for railway stocks. The constantly diminishing yield on the "gilt-edged" securities also is a strong incentive to the purchase of the ordinary stocks of railways, which offer, in compensation for the additional risk, a substantially larger yield.

In spite of the very large advance in the quotations of the ordinary stocks, the concurrent improvement in the gross receipts has been so great that the average yield, based on a conservative estimate of the dividends for the year ending June 30, 1896, is fully 3⅜ per cent. Nearly a dozen important stocks yield more than the latter rate. This yield represents, too, only the probable outcome of the improvement in gross revenue already in hand, and takes no account of the very probable further improvement in dividends in the second half of 1896.

This yield, even allowing that prospects are good, is undeniably a low one for a railway ordinary stock, and, without doubt, implies a large measure of confidence on the part of those investors who are prepared to take these stocks with only this small return. And that confidence has hitherto been well merited, while, as regards the smallness of the yield, the capitalist who patronizes these stocks is apt to say to anyone who criticises his judgment: "Show me where I can do better elsewhere." The long period of cheap money has added a string of difficulties for the capitalist to meet as best he may.

The yield on Consols in 1885 was very nearly 3 per cent., for, while carrying that rate then, they were not throughout the year quoted higher than 101½. At the present time they bear interest at the rate

of 2¾ per cent., which rate continues until 1903, when they become automatically only a 2½ per cent. security redeemable at par in 1923. They are now quoted at over 113, and the true yield at the present time is, therefore, considerably under 2 per cent. Corporation stocks yield little more than 2½ per cent.; some yield even less. British railway debenture stocks of good lines yield only about the same rate. The Great Western company actually succeeded in placing a 2½ per cent. debenture stock issue at 104½ recently! This is the first issue of a stock of that denomination by an English railway. The best preference stocks yield barely 2⅝ per cent. In 1885 the 4 per cent. debenture stocks of the North Western and Midland Companies stood at 123 to 125. Now the 3 per cent. stocks into which they have been converted stand at the same figure, the yield having thus declined four-fifths of one per cent. In the light of these facts is it, after all, so extraordinary that the ordinary stock of the North Western Company, which in 1885 received 6½ per cent. dividend and was not then quoted higher than 171, should at the present time stand at 200, with a dividend on the present results of 6¾ to 7 per cent., or that Midland Railway ordinary stock, which in 1885 received a dividend of 5⅛ per cent. and did not command more than 135, should now stand at 168 with a current dividend of about 5½ per cent.?

As regards the confidence reposed by British investors in the railways of the United Kingdom as channels for investment, is there not ample justification for it? They are ably and, above all, honestly managed. Those concerned in the actual conduct and management of the traffic of British railways are not concerned directly in the financial administration; therein lies their strength. The evils of the dual control—the same persons having control of the management and the finances of the railway—are well set forth by the results of American railways, and it is undoubtedly one of the weakest points about the latter from the British investor's point of view.

English railway accounts are not perfect, but they are honest and straightforward, as a rule. They are audited half-yearly, and the official figures have to be filed with the board of trade. Above all, there is no manipulation of figures for market purposes, either as regards the half-yearly accounts or the traffic publications. In his article on "The Fruits of Fraudulent Railroad Management" in the June issue of the ENGINEERING MAGAZINE Mr. J. Selwin Tait, rightly says: "The principal source of distrust in American railways . . . . is the manipulation of accounts." English railways have to make up their half-yearly accounts in a form specially designed for them, as enacted by the Regulation of Railways Act of 1868, which applied to all railways then in existence and has been in-

corporated in all special acts since. British railways, it may here be pointed out, hold their right of existence direct from imperial parliament through special acts passed in the case of each undertaking. In addition, there are numerous enactments relating to railways only which regulate their conduct, unless the provisions of the general acts are specifically varied by the special act of an individual company. The advantage of the special act in the case of each company is that parliament, having granted certain privileges on the terms of which the capital for the lines was provided, must always recognize its obligation to protect the railways from confiscatory measures.

A feature about British railway stocks is that, unlike the majority of American common stocks, they represent actual cash payments, sometimes of considerably more than their par value; North Western ordinary stock, for example, has had over £115 paid in cash to the company for every nominal £100 in existence.

Though in several respects capable of improvement, the railways of the United Kingdom are, on the whole, sound undertakings, ably administered and financially strong. Nothing probably has more strengthened the confidence of investors in British railway securities during the last four years than the contrast they have presented with American lines, for it is precisely those evils which, in the case of the railways of the United States, have been so woefully exemplified during late years that are most alien to the constitution of the railways of the United Kingdom. The railways of both countries have come through a period of exceptional adversity,—surely one of the truest tests of stability,—but how differently! A large proportion of American roads are still in the hands of receivers, and the fixed charges of many others have had to be cut down. On the other hand, the credit of British railways is now better than ever before, and all have come through the trying times unscathed and in a position to benefit fully from the trade improvement now in force. There is thus every reason to regard the stocks of British railways as thoroughly good investments.

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Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
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Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.

Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining, *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8*s.* London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50 London
North American Review. *m.* $5. New York
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York
Street Railway Review. *m.* $2. Chicago
Technograph. *yr.* 50 cts. Urbana, Ill
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

The Tenement House Competition.

THE wish to be just in ascribing honor to whom honor is due is common to all right-minded men. The recent award by the commission of the "Improved Housing Council" gives occasion to our esteemed contemporary, *The Engineering Record*, to assert its claims as a pioneer in this kind of competition. In 1879, while it bore the name of the *Sanitary Engineer*, this paper had much to say upon the subject of improved tenement houses, and said it well. Those familiar with the paper at that period will remember that it instituted a competition, in which architect James E. Ware was the successful competitor. This gentleman is also one of the successful competitors in the competition of the Improved Housing Council, the other successful ones being architects Ernest Flagg and A. W. Ross.

The *Sanitary Engineer* was, therefore, among the first publications in the United States to emphasize the need of improvement in tenement house architecture, to demonstrate the possibility of such improvement, and, through the design of Mr. Ward, to indicate the lines upon which such improvement should advance. This busy age moves so rapidly that the recollection of details of events is soon effaced by events which follow. Therefore in its issue of June 6 *The Engineering Record* very properly recalls the facts above stated, the principal difference of the recent competition from that of 1879 being that the conditions apply to the construction of an entire block, whereas the former competition applied to a single tenement building. Nearly all the conditions of the recent competition correspond with those of the single tenement building as set forth in the competition of 1879.

All apartments were required to be lighted by windows directly opening upon the outer air, and to have cross ventilation. Each compartment was required to have an independent fire-proof staircase inclosed by brick walls and having a separate entrance from the street. Each suite was required to have its separate water-closet opening directly to the outer air. Each living-room was to be accessible without passing through any other room, and entrance to each bed-room without passing through any other bed-room was to be provided. Living-rooms were to have one hundred and forty-four square feet of space, and bed-rooms seventy square feet. Height, six stories.

The features of the plans prepared respectively by the architects named, as published in the New York *Tribune*, are as follows:

"Mr. Flagg divided his block lengthwise by a passage about 30 feet in width. On each oblong rectangle he puts four square pavilions separated by courts 18 feet wide and 60 feet deep, opening from the street, leaving the wall line on the interior passage unbroken. Each pavilion has a court 30 feet square. The staircases, four to each pavilion, open on the corners of these courts, and are set diagonally, leaving all possible window space for the apartments. There is an open lift for every two apartments. Generally three suites open on each staircase at every floor. In the arrangement of rooms Mr. Flagg has a living-room, from which in most cases opens a kitchen with a sink. Then there are one or two bedrooms. This living-room is the passageway to the kitchen. The water-closets of the different suites are generally separated by some distance, thus requiring extra piping, and either opening directly from the living-room or on the pavilion courts, where they can be reached only through an open balcony. Mr. Flagg has secured excellent cross-ventilation, as one or more rooms of each one of his suites open on the outer air, while others look on the pavilion court.

"Mr. James E. Ware goes even further than Mr. Flagg in arranging for air currents through the block. He divides it

transversely by two narrow alleys about 100 feet from each avenue, and connects these alleys by a third alley down the middle of the block, so the three passages form a letter H and divide the block into four equal parts about 100×200 feet, each with a long side or street or avenue. On each plot are built two pavilions, cut nearly in two by a deep court, with a court 30 feet square in the middle of each pavilion, similar to the plan of Mr. Flagg, except that these square courts are all connected with the outer air by one and, in some cases, two slits, from the ground up, thus making the building outline of two pavilions resemble that of a rectangular figure 3. The main entrances are through arches into the pavilion courts, and corner staircases give access to three or four apartments on each floor, somewhat as in Mr. Flagg's designs. The water-closets all open on private halls, and are exceptionally well arranged for tenants. The number of apartments in this design is the same as in Mr. Flagg's, but the rooms are small. Mr. Ware gives the maximum of draft between the parts of his building, but both he and Mr. Flagg have many apartments that look out on the interior alleys.

"Mr. A. W. Ross gives every suite an outlook on the street, and at the same time on an interior court. Like the other two architects, his building is about 30 feet deep between exterior walls; but, instead of arranging his floor space about small courts, he connects it all about a great central court, getting open wall space by turning his walls in and out like a Greek fret. That is, the hollow square of a building is deeply indented by courts 30 feet wide from the street alternately with narrower courts from the long, alley-like court through the middle of the block. There is a staircase for every pair of apartments, and they are partly internal and partly external. Cross-ventilation for corner suites is secured by turning a special external half-staircase from the main stairways, situated at the ends of the interior courts. These steps go only to the single apartments, and the door opening on the air makes a draft from the rooms outside to the court possible without surrender of privacy. Comparatively few of the apartments look directly on the street, but there is not one from the windows of which a view down the broad court to the street may not be had. Those nearest the street look out almost directly, but even far back in the court the angle is not more than 45 degrees.

"The living-rooms in the plan of Mr. Ross are generally large and well arranged. The living-rooms all open to the front, as well as some of the bedrooms, while the water-closets are on the courts and are entered from private halls. There is an interior lift for each two apartments."

Competitions in Design.

WAS there ever a competition between artists without an exhibition of jealousy unworthy of those who display it? Was there ever a beautiful woman that would acknowledge the existence of equal beauty in a rival? Whenever a prize competition is instituted, the apple of discord is thrown.

Not to speak of recent examples of reciprocal jealousy among sculptors, painters, actors, and musicians, the competition mentioned in the previous article has again shown that even architects of reputation and ability are not above this weakness.

Not content with being among the three honored with awards, out of twenty-eight competitors, it is said (New York *Sun*, June 10) that Mr. Flagg charges plagiarism against Mr. Ware, who won the first prize in the competition of 1879. The specific charge is that Mr. Ware has copied features of a design prepared by him and illustrated in *Scribner's Magazine* some two years ago. As these features were, according to the reply of Mr. Ware, embodied in a building erected by the latter four years ago, it seems that the charge of plagiarism must return upon Mr. Flagg, although Mr. Ware is magnanimous enough not to make such a charge, and justly recognizes that, under a set of rigid conditions, like those to which the architects were confined, it is not unlikely that

some features in each plan would be like those in some of the others, or in previous plans. Resemblances thus originated are not necessarily plagiaristic, since they might correspond with something the designer had never seen, and be virtually original with himself; or, though previously known, they might be compelled by the conditions.

It is unfortunate that such squabbles should result so often from competitive work; they are extremely tiresome to the general public.

The English Brickwork Tests.

THE Royal Institute of British Architects has, through a committee, been carrying on a series of experiments to ascertain the ultimate crushing load of brickwork columns, so that the relative strength of such may be compared with the resistance possessed by the individual bricks of which they are composed. The results of the first series of experiments were recently laid before the Institute, and are admirably summarized in *The Builder*. A full account of the experiments is given in the *Journal of the Royal Institution of British Architects* (April 2).

A table of average results shows that the strength of brickwork is not so great as it has been assumed to be. The piers tested were erected five months prior to the tests, and a further series of experiments is to be made on piers after ten months, which may show greater strength. The utmost care was taken in the construction, though the effort was to produce piers which would represent everyday construction, rather than those built under exceptional conditions. An hydraulic apparatus exerting a pressure in excess of five hundred tons was employed in the experiments.

The tests developed a remarkable difference between the crushing of separate bricks and of piers composed of the same sort. A pier of Leicester red bricks was crushed with from 29.93 to 67.36 tons, while single bricks sustained 311.4 tons to 591.4 tons. That the difference was not caused by the pointing was shown by a number of photographs, in which the tendency to crack in the center was distinctly visible. Some failures, however, were shown on the lines of vertical juncture, and it may be questioned if we use the best method of bonding for resisting pressure. It was further shown that half bricks crush at a lower pressure than whole ones, the difference, in some grades of brick, being as much as one-half.

A Stand-Pipe Plumbing System.

AN example of the plumbing system herein presented has been erected in the College of Physicians and Surgeons in New York city. The description of it is condensed from *The Engineering Record* (June 15).

"Instead of pumping all the water used into an elevated tank and distributing it thence to the different lines in the house, the water is pumped into a comparatively small stand-pipe that does not serve in any considerable way to provide storage, but rather acts as a pressure regulator for the pump to act directly against and maintain the supply and head of the water used in exact accordance with the amount used, thus promoting simplicity and directness, and virtually applying to a domestic installation the system long ago adopted for municipal water-works and known as the Holly system. The water is received through meters from two street mains into an open suction tank in one corner of the engine-room, which has sufficient storage capacity to provide for an even pump action, is filled through ordinary ball cocks, and is covered by a light-hinged iron plate and manhole. From this tank the water is pumped through an 8-inch suction line into the foot of a vertical column of 12-inch pipe, about 120 feet high, and from the 6 inch pump discharge which is connected to this stand-pipe the different lines to distribute the water throughout the building are branched. Each of them is thus in free communication with the stand-pipe, and receives from it pressure due to the head of water in it, equivalent to being connected with an elevated tank as high as the level of water in the stand-pipe, and avoiding the necessity of providing a support for sev-

eral tons of water in the top of the building. The corresponding requirement is that water should be constantly pumped into the system as fast as it may be drawn out, so as to maintain a regular pressure. This is easily provided for by requirements of the fire protection system, which would close the valves, V V, and, shutting off the steam, stop the pumps when the head of water in the stand-pipe rises above the required level, and open them and start the pumps when the water falls below this level. These regulators, R R, are of the ordinary kind, having a piston on the

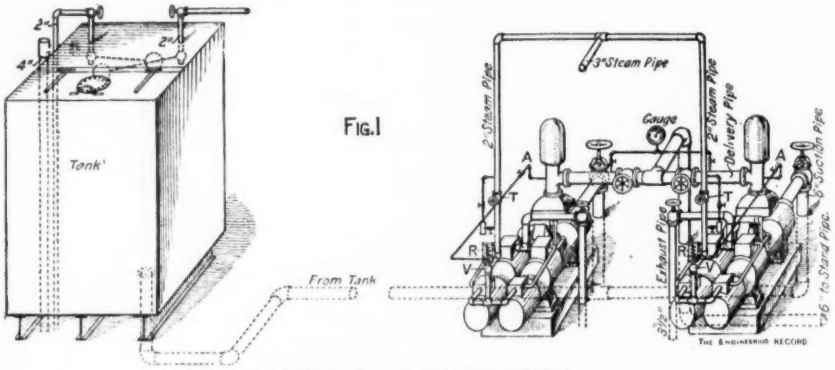


FIG. 1

A STAND-PIPE PLUMBING SYSTEM.

have been installed independently of this feature in any event."

Two Snow duplex pumps (Fig. 1) "have their supply and discharge mains laid in floor conduits which are accessible through checquered cast floor plates of a conven-

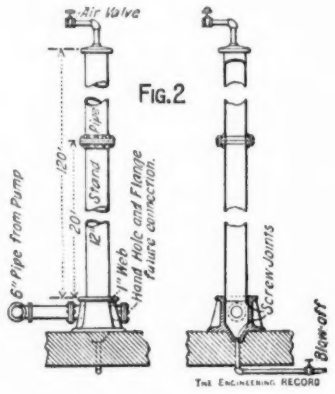


FIG. 2

ient size, and the steam supplies are governed, inside the throttle valves, V V, which are ordinarily left open. They may be operated at will by hand by Ford's patent regulators, R R, that automatically

upper end of the produced stem of the valve, V, and a spiral spring attached to the stem above the piston in such a manner as to open the valve until the pressure in the stand-pipe becomes too high. The regulator piston works in a small cylinder, which is in free communication, through the open pipe, A, with the pump discharge, and, when the pressure there becomes too high, it overcomes the effect of the spring, and the piston moves in the cylinder against the spring and closes the valve, V. The gage is connected very close to the air chambers on the discharge pipe in such a manner that, if the pump was accidentally started with its discharge valve closed, the gage would instantly indicate it by violent fluctuations."

The stand-pipe is made of six 20-foot lengths of $\frac{5}{16}$-inch galvanized wrought-iron pipe 12 inches in diameter, screwed into flange collars bolted together. The base of the stand-pipe is a casting shown in Fig. 2, supported on a masonry pier. The conical section of the casting facilitates blowing out sediment. "The top of the stand-pipe is closed and provided with a safety overflow pipe and valve. Normally the valve is open, but it may be

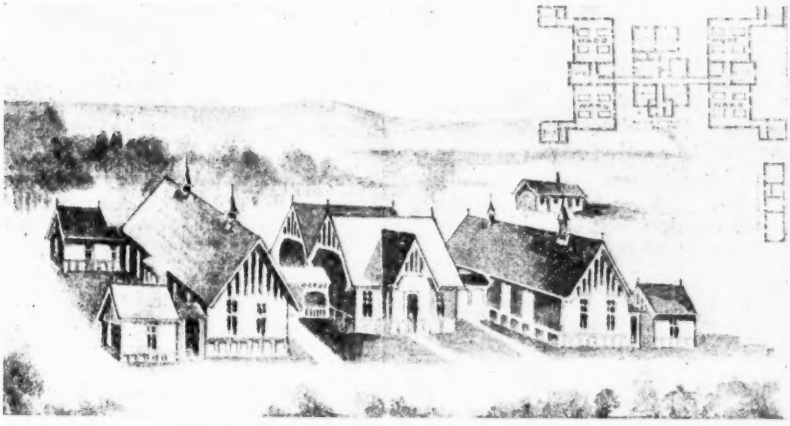
closed to permit the maintenance of a high pressure for fire or other purposes; greater than can be secured from the head due to height of the pipe alone. Practically it is found sufficient to keep the stand-pipe filled with water up to about 20 feet below the top." This is a well-designed system, with details carefully worked out, and, although unusual, we see no reason to suspect it of inefficiency or inconvenience.

Pest-House Architecture.

AN example of a design for a hospital for infectious diseases, by Messrs. Speirs and Co., a firm of Glasgow architects, affords a pleasing contrast to many of the buildings used by American cities for the purpose of isolating infected patients, and which are "pest-houses," not only in the sense that they are used for the treatment of pestilential diseases, but also in the sense that in appearance they are offensive to taste, and in their facilities for proper care of the unfortunates confined in them a disgrace to civilization. The firm of architects named has become noted for hospital construction, and this hospital has been built on a patented system which the firm has applied in a large number of similar buildings in Scotland.

We herewith reproduce from *The Sanitary Record* (May 29) an engraving of the building referred to, which has been erected at Newton Stewart.

It consists of three blocks, having wood weather-board walls and iron-sheeted roofs. The interior is lined with special tongued and grooved stored lining, all neatly stained and varnished, and presents a most comfortable appearance. The space between the outside and inside covering is divided into two spaces by non-conducting sheathing material, thus forming air-cushions, and absolutely ensuring that the building is impervious to either heat or cold. The hospital consists of two fever pavilions, each divided into two wards, with accommodation for sixteen beds in all. Between the two wards in each pavilion there is a nurses' duty-room with observation windows overlooking each ward, and to each ward there is separate lavatory and bath-room accommodation. Between the two fever blocks, and connected to same by open corridors, there is the administration block with doctor's and matron's room, kitchen, scullery, pantry, linen-store, coal-house, heating-chamber, and two small isolation or private wards. A short distance from the main buildings is placed the outhouses block, comprising ambulance shed, disinfecting-room, mortuary, wash-house, and laundry. The buildings throughout are fully equipped with the latest sanitary and other hospital



INFECTIOUS DISEASES HOSPITAL AT NEWTON STEWART.

appliances. The heating of the wards is obtained by low-pressure hot-water system, and a hot-water-supply is carried from the administration block to all the sinks, bath-rooms, etc., of the wards.

Without describing the particular features of the patented system, *The Sanitary Record* commends it, and says that the local government board thoroughly approves it.

The Impending Doom of High Building.

THE high-building boom, in the opinion of *Architecture and Building*, has had its day. Under the title, "Shipping and Transit Needs of New York," this journal editorially discusses a number of improvements which the recent enlargement of the city boundaries, and consequent increase of population in what have been hitherto suburban districts, will demand. As pertinent to the subject, it notes that the enormous centralization of business in and about Broadway, threatened by the erection of tall buildings, would greatly increase the difficulty of comfortable transportation, and will, in all probability, be restricted. In this department of our July number mention was made of the Pavey bill, which provides for such restriction, and of the action of the American Institute of Architects, in strong approval of the purposes of the proposed legislation. To this purpose the large majority of the general public will also say amen. The present attitude of the foremost architects and of public opinion toward the further extension of tall building is well put in the editorial referred to, which, with reference to the pending bill, says:

"That such legislation is more than probable may be inferred from the efforts already made in this direction and the discussions going on in architectural and building circles. Many of our readers will remember the report of the discussion on the Pavey bill, where some of the very architects who had been the largest designers of such buildings strongly advocated restricting their height. In other cities such laws have been passed. Boston has the matter under consideration, as has St. Louis; and Chicago—the birthplace of the skeleton structure—has already passed a law to this effect. Under the influence of such a law the effect would be to so extend the area of the business portion of the city as to crowd, especially in the lower part of it, on to territory at present occupied by warehouses and manufacturing establishments and drive them in turn into the tenement districts, resulting in a larger patronage of marginal roads; so that a far-sighted view of the city's needs in this matter must take into account changes such as the one referred to. Besides, it would be no difficult matter to provide crosstown roads on depot streets, which would make these roads quickly and easily accessible."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

*6508. The Architecture of Home-Making. Ill. Charles E. Benton (A discussion of the effect of home architecture on the home and the family). Eng Mag–July. 3500 w.

6559. The American Surety Building. (Illustrated description of foundation piers, column footings, cantilever girders and anchorages). Eng Rec–June 13. 1000 w.

*6572. Rocks and Building Stone. Dr. A. P. Coleman (From the report of the Ontario Bureau of Mines, 1893. Considers rocks from the geologists as well as the architects point of view, and gives description and analysis of the kinds most used for building, and the tests that should be made to determine the strength and durability). Stone–June. 1600 w.

†6576. Baroda Palace: the Town Residence of H. H. Sir Syaji Rao, G. C. S. I., Maharaja Sahib Gaekwar. Robert Fellowes Chisholm, with Discussion (Description of a palace in India, probably the most costly structure erected by a private individual during the present century). Jour Roy Inst of Brit Archs–May 21. 10000 w.

*6580. Old London Churches (Editorial review, with illustrations, of a book by George H. Birch). Builder–June 6. 3700 w.

*6587. "The Old Paths, Where Is the Good Way?" (Comparing some old things with some new, viewed from an architectural standpoint, to try to find out "the good way" in the past, then proceeding to describe those points wherein the men of the present have undoubtedly improved "the old paths"). Arch, Lond–June 5. Serial. 1st part. 2200 w.

†6658. Romanesque Architecture. Grant C.

We supply copies of these articles. See introductory.

Miller (A study of this style of architecture from the tenth century with illustrations). Tech–May, '96. 4800 w.

†6668. The Construction of Sky-Scrapers. C. T. Purdy (The knowledge required for success in structural iron work, especially house building; the importance of accuracy, and of safe foundations). Trans Assn of Civ Engs of Cornell Univ–June, '96. 6400 w.

6712. An Iron Synagogue Roof and Dome (Illustrated brief description of the new Temple Shaare Emeth in course of construction in St. Louis, Mo). Eng Rec–June 20. 500 w.

*6717. A Restaurant de Luxe (Illustrated description of an elegantly appointed establishment opened in the Prince's Hall, Piccadilly). Arch, Lond–June 12. 800 w.

*6718. Greek v. Roman Construction (Extract from a pamphlet entitled "Prologmenos on the Function of Masonry in Modern Architectural Structures," by R. Guastavino, architect, New York). Arch, Lond–June 12. 1600 w.

6724. Architectural Competitions. John A. Fox (Read before the Boston Soc. of Archs. An introduction to a discussion followed by papers by R. D. Andrews, and H. Langford Warren, with reprint of the "Abstract in a Projected Tract on Competitions," published in this journal in Jan. 1876). Am Arch–June 20. 8500 w.

*6755. The Housing of the Poor (What is being done in London and in Dudley). Rev of Rev, Lond–June 15. 3500 w.

*6821. Spanish Brick and Tile Work. C. H. Blackall (Illustrated description of architectural work in this material, especially of the Moorish style). Br Builder–June. Serial. 1st part. 2500 w.

6822. Improved Tenements. George W. Da Cunha (A discussion of the general principles upon which tenements should be constructed). Am Arch–June 27. 2600 w.

6897. The Ashmont Engine-House, Boston, Mass. (Illustrated description). Eng Rec–July 4. 1100 w.

*6922. Modern Opera Houses and Theatres (Editorial review of a book by Edwin O. Sachs and Ernest A. E. Woodrow, with comments). Builder–June 27. 3000 w.

6937. Old Lombard and Venetian Villas. Vernon Lee in *Cosmopolis* (An account of travels with but slight reference to the architecture in this first part). Am Arch–July 4. Serial. 1st part. 3000 w.

Heating and Ventilation.

6534. Pressure Records from a Vacuum Steam Heating System (Data from records of observations of vacuum steam heating plant in a building exposing 28000 sq. ft. of surface to northerly winds). Eng News–June 11. 500 w.

†6661. Heating and Ventilation by the Hot Blast System. F. H. Green and T. Weinshenk (Experiments with plant at the High School building at Champaign, Ill., with illustrated description of the heating and ventilating apparatus). Tech–May, '96. 1400 w.

6678. Ventilation and Heating of School Buildings with Furnaces. J. L. Bixby, Jr. (A practical essay profusely illustrated in which the subject is ably treated). Met Work–June 20. 2000 w.

*6692. German Heating. Ill. (An interesting exposition of the methods employed in heating German houses). Dom Engng–June. Serial. 1st part. 1500 w.

6693. Heating and Ventilation of the Fitchburg (Mass.) High School (Illustrated detailed description). Heat & Ven–June 15. 1800 w.

6694. English Water-Backs. Frederick Dye (Review of English Practice). Heat & Ven–June 15. 1800 w.

6707. The "Vacuum" System of Heating. C. C. Dennis (A comparison of the advantages possessed by two different methods of operation of the system). Ir Tr Rev–June 18. 2200 w.

6713. Heating of the Medical Baths at Bellevue Hospital, New York City (Illustrated description of apparatus recently erected in this institution). Eng Rec–June 20. 700 w.

6790. Plumbing in a New England Residence (Illustrated detailed description). Eng Rec–June 27. 1200 w.

6899. Hot-Water Heating in a Baltimore Building (Illustrated description with plans of the heating in Notre-Dame Institute). Eng Rec–July 4. 700 w.

Landscape Gardening.

6601. An Architectural Garden. Thomas Hastings (A description of the grounds and buildings of E. C. Benedict, on the site of the old Indian Harbor Hotel). Gar & For–June 17. 2200 w.

6819. The United States and the Palisades. Ill. (A statement and discussion of the grounds on which interposition of the National Government is asked for the preservation of the Palisades). So Arch–June. 1200 w.

6955. Privacy in Suburban Life (Editorial review of an article on "Suburban Homes" in *The Cosmopolitan* for June, by R. Clipston Sturgis, with criticism of the homes of Americans, and their lack of individuality, and the character of the grounds). Gar & For–July 8. 1500 w.

Plumbing and Gas Fitting.

6560. A Stand-Pipe Plumbing System (Illustrated description of a system of distribution involving a departure from ordinary methods, by providing an artificial pressure above the street mains). Eng Rec–June 13. 900 w.

*6690. Samples of Work (Illustrated description of notable exhibits at an exhibition held in connection with the sixth annual congress of plumbers in Dumfries, Scotland). Dom Engng–June. 350 w.

*6691. Sanitary Schools (Abstract of a report upon Boston schools, by a committee of experts. The article is well illustrated with engravings of model and defective plumbing and drainage, ventilation and heating work). Dom Engng–June. 1900 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The New East River Bridge.

THE project for a new bridge across the East river is beginning to emerge from the silence and comparative indifference which have so long kept the enterprise in the background, and to assume the interest which attaches to it chiefly as a temporary alleviator of the discomforts of travel between New York and Brooklyn.

The limitation is affixed advisedly; problems of transit in the greater New York are too large and too intricate to be much affected by any partial solution. When relief is afforded in any one direction, it merely seems to attract the ultimate surplus from other overcrowded channels, with the result that the congestion is soon equally bad on the new route and the relief to the other almost inappreciable.

It is almost inexplicable that this particular work has been so long delayed and so patiently awaited. The original structure had to win converts to its engineering possibility and fight the battle with navigation interests; these contests once over, it might have been expected that additional structures would have followed rapidly where the need was so great. Many of the smaller western cities have facilities enormously greater in proportion to the traffic, secured in the face of much more strenuous opposition from those interested in river transportation.

A very small increase in convenience or accessibility is found, not only to direct travel to a particular bridge, but to increase materially the total amount of traffic. Cincinnati, with five bridges, is vastly better equipped than New York will be with its two great structures and all its ferries; yet two of the five are being enlarged, and a sixth is projected.

Tunnel schemes, which at one time seemed likely to rival bridges in popularity, have fallen back again. The uncertainties of construction are greater, or at least are so considered, and underground travel is not in favor with the public, partly on account of difficulties of ventilation, but chiefly, in all probability, on account of an undefined repugnance. Curiously, a more material objection, from the engineer's point of view, is developing in connection with the Thames tunnel. It is reported that the increasing draught requirements of modern vessels threaten to leave an insufficient depth over the top of the tunnel, and the structure is likely to become the very thing for the avoidance of which it was constructed,—an obstruction to navigation.

The East river bridge presents few new features of construction, except in matters of detail; that is, it will be a suspension bridge, generally similar to the Brooklyn bridge now existing, supported by four steel cables carried over skeleton steel towers. The New York approach will be on the blocks bounded by Clinton, Delancey, Norfolk, and Broome streets; the Brooklyn approach, at Fifth and Roebling streets.

The sites for the foundations of the two piers have been decided upon, says the *Railway Review*, and the boring is now going on. "Just beyond the head of Delancey street wharf four holes have been bored in the bed of the East river with diamond drills, and the results attained have given assurance that a solid gneiss rock lies at a depth of sixty-one feet below water on the New York side. In descending to the rock foundation to build the piers, the method to be employed will be the same as in the work on the Brooklyn bridge twenty-five years ago. Caissons will be constructed, probably of steel, instead of wood, as formerly, and these will be sunk by weights of masonry. In the chambers within the caissons, to which the water cannot penetrate, the workmen will clear the rock of all earth and prepare a foundation of cement and broken stone. The two towers of steel will rise 332 feet above the water. Each tower will rest on four legs standing on the four corners of each caisson. About

117 feet above the river there will be an arched space, through which the main roadway for cars and foot passengers will pass.

"There will be six railroad tracks, two for elevated railroad trains and four for electric and other surface cars. Above this roadway, it is proposed, broad footways will be constructed, and also a bicycle path. Upon the level of the railroad tracks and between the legs of the towers will be an arched space on each side of the large one, for use as carriage ways. The width of the new bridge will be 117 feet, or 37 more than the old one.

The span from tower to tower will measure 1,610 feet, 15 feet longer than the Brooklyn bridge. The cable will be about 18 inches in diameter, three inches greater than those now supporting the enormous traffic between the two cities. In each cable will be 5,149 wires, and every strand will be capable of carrying a load of 5,000 pounds."

The commissioners expect to have the work complete by the year 1900, which would be very quick time.

The estimated cost is $15,000,000.

Echoes of the Kiel Opening.

THE Baltic and North Sea canal, judging from a recent review in *Transport*, must be classed among the disappointments in recent large engineering construction.

Not even the extensive advertising which was given it by a magnificent and widely-heralded opening, and which is supposed to be so large a factor in success, has attracted a sufficient volume of traffic to defray more than a fraction of the expenses. "Since the official opening, less than eight thousand vessels have passed through, none of them being of very large tonnage, and the receipts did not exceed 605,000 marks." The annual expenses are stated to be about three million marks. The calculations of the managers were that the annual revenue would be 5,000,000 marks, based on a traffic of 7,500,000 tons.

Transport attributes the small use made of the canal to the indifference of vessel-owners generally to a minor saving in time. Delays in loading and unloading are so customary, and are regarded as so unavoidable a feature of water transportation, that a little shortening of the route offers no inducement, especially when canal tolls must be set over against it. It might reasonably be expected that education in better facilities would overcome this indifference, and it may still be argued that, like other new departures, the canal must have time to introduce and commend itself to patronage, and that it is not fair to measure its ultimate success by a portion of the first year; but a graver reason is suggested by the significant remark that none of the vessels passing through were of very large tonnage,—indeed, as later noted, the "average size of the vessels which take advantage of the canal is 110 tons." The natural expectation would be that large vessels, being generally run on the lines of closest economy, would be the very ones to which the gain in time would be important, and that they would be the first to avail themselves of its advantages, unless there were strong deterrent reasons.

A possible discouragement (and a very serious one) will at once suggest itself to all who remember the grandly melancholy spectacle of the official opening, when the warships of all nations were supposed to pass proudly through the new waterway, but instead vied with each other in emulating the example of the hippopotamus in the song of Noah's Ark.

It was broadly hinted then that the canal would have been a better canal if naval and engineering expert advice had been followed, instead of being overruled by imperial dictum. There is no royal road to canal construction, and this royal canal seems to have the one important defect that the vessels for which it was especially intended fear such difficulty in traversing it that they are deterred from making the attempt.

Transport offers the consolation that by means of the canal "the German naval forces can concentrate themselves either in one sea or the other in a very few hours"; so they may—providing that they do not, in making the attempt, concentrate themselves midway of the canal.

The Nicaragua Canal Termini.

A VERY interesting letter from Mr. Silvanus Miller, C. E., is printed by *Engineering News*, and is an especially valuable contribution to the canal discussion, because of Mr. Miller's familiarity with the subject and ample opportunity to study climatic conditions on the ground during a considerable period.

Incidentally some suggestive hints are given as to the comparative endurance of earthworks in tropical climates.

In the absence of the disintegrating action of frosts, and in the rapid growth of a protective cover of vegetation, Mr. Miller finds preservative conditions very largely offsetting the effect of the heavy tropical rainfall.

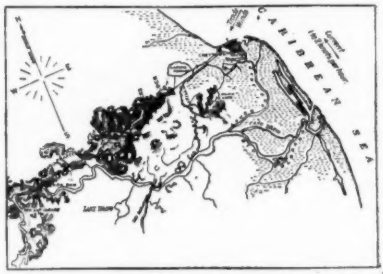
His statement that very steep slopes (from perpendicular to ½ to 1) stand better than flatter ones is more startling at first, but perfectly reasonable on a moment's reflection, the explanation being simply that much less surface is exposed to the rain.

The most important comment, however, is that made upon the proposed terminal harbors and their improvement,—points which were outside of the scope of the article in the June number of THE ENGINEERING MAGAZINE, and therefore were only alluded to therein. Mr. Miller's criticism is made clear by a map accompanying his letter, which is here reproduced with his remarks as follows:

"I still believe that the best method for making and maintaining a good port at Greytown would be by turning all the water of the San Juan river into the harbor once more. This, with a properly devised system of jetties, should be sufficient to scour out the harbor, and maintain it at a sufficient depth at all times. The accompanying sketch shows the general direction of the winds and currents at this point. All the sand that is now brought down by the Colorado branch is carried up the coast by the drift and deposited behind the point in front of Greytown, while, if this sand were brought down into Greytown harbor itself with the full current of the river, it would be carried out to sea and drifted on up the coast in the direction of Monkey river. I believe that this subject is well worth a careful study, and am not aware that proper attention has been directed to it.

"As long ago as 1888 I pointed out to Mr. Menocal the uselessness of the jetty as proposed by him to stop the drift of sand up the coast, and I now see from the report of the commission that exactly what I predicted has happened, as the sand has already filled in behind the jetty and is drifting around the end of it, and this will continue to happen, no matter to what length this jetty may be extended, although, of course, a jetty could be extended far enough to stop the drift for many years.

"With regard to the port on the Pacific coast, Brito is certainly a miserable little hole. A canal like this should have a port capable of holding a large number of vessels at one time, for various reasons.



Direction of Winds and Currents at the Atlantic Mouth of the Nicaragua Canal.

To make such a port at Brito would be a very expensive affair, and I believe that further surveys should be made to demonstrate if it is practicable or not to carry the canal to Salinas bay, which is a most magnificent harbor, and capable of holding the navies of the world.

"I am not aware that anything more than a slight reconnoissance has been made of this route, and I believe that a careful topographical survey should be made between the lake and Salinas bay, so that an opinion could be formed as to the cost and practicability of this route. I think it would be well worth while to spend a few millions more on the canal, in order to obtain the benefits of the most magnificent harbor."

Mr. Miller closes with an expression of

the sentiment recently expressed in these pages: "By all means let us have the most complete and thorough surveys, even if they cost $500,000 and three years' time, and do not let us make the mistakes of Panama by commencing work before we know 'where we are at' as regards some of the most serious problems connected with the construction of this important canal."

Compressed-Air Work and the Hudson Tunnel.

THE MINING JOURNAL, RAILWAY, AND COMMERCIAL GAZETTE (London) is publishing as a serial a paper read by Mr. E. W. Moir before the Society of Arts in May last on the subject of "Tunnelling by Compressed Air,"—a paper which is full of interesting information, not only upon this class of work in general, but upon special matters connected with the larger undertakings of this class, with many of which Mr. Moir has been connected, notably the Blackwall tunnel now being constructed for the London county council, and the Hudson river tunnel, from which great things were expected, but which is now dormant.

It was in connection with this latter work that Mr. Moir instituted a peculiarly successful treatment for men suffering from the effects of compressed air. He says: "When I first went to New York, the men had been dying at the rate of one man per month, out of forty-five or fifty men employed,—a death rate of about twenty-five per cent. per annum. With a view to improving this state of things, an air compartment like a boiler was made, in which the men could be treated homœopathically, or reimmersed in compressed air. It was erected near the top of the shaft, and, when a man was overcome or paralyzed, as I have seen them often, completely unconscious and unable to use their limbs, they were carried into the compartment and the air pressure raised to about half or two-thirds of that in which they had been working, with immediate improvement. The pressure was then lowered at the very slow rate of one pound per minute, or even less, the time allowed for equalization being from twenty-five to thirty minutes, and even in severe cases the men went away quite cured. The medical lock should be used at once, as it does not appear to have much effect after some time has elapsed. Such an appliance had never been used before it was introduced by us at the Hudson tunnel. Fortunately there have been no deaths, but there have been some cases of paralysis which were immediately cured in the lock, and there have been a few cases of vertigo, one of which was more or less permanent, though the man is slowly recovering. The great necessity is to have plenty of air, and, as the pressure increases, purity must be greater."

Mr. Moir attributes the bad effects largely to carbonic acid, and especially to a sudden simultaneous increase of pressure and impurity. He advances the suggestion that, under increased pressure, the blood actually dissolves an excess of carbonic acid, which is suddenly liberated when the pressure is removed, and he advocates the passing of all air intended for high-pressure caisson or tunnel work through lime-water, which will absorb and remove the excess of carbonic acid. He would examine applicants for work carefully, rejecting any with a tendency to apoplexy or heart trouble. Sparely-built men, not too full-blooded, he considers best adapted to the work. At the Blackwall tunnel no deaths have occurred, although the men are working under thirty-seven pounds pressure. The good record Mr. Moir attributes to the use of the medical lock and the careful observation of the points learned by experience.

It may be of interest to quote his summary of the work done on the Hudson river tunnel, and the present status of that undertaking. "The Hudson tunnel was commenced in 1879, and is the first tunnel in which compressed air was used, although, as already stated, it was suggested by Admiral Cochrane in 1830. It was driven entirely through soft river mud or silt, so fluid that it will flow through a slit ½-inch wide for weeks against a pressure little less than the hydraulic head. About 2,000 feet were driven by means of com-

pressed air, and what is known as the pilot system of tunnelling, invented by Mr. Andersen, a Swede, and first applied in the Hudson tunnel by him. Very good progress was made by this means, but, as the tunnel was extended further under the water and approached nearer the river-bed, the silt became more fluid, and the air pressure necessary to keep it back at the bottom was more than the reduced depth of mud above would stand, and several blow-outs occurred. It became necessary, therefore, to introduce the shield and cast-iron lined system to make further progress, and in 1889, on the recommendation of Sir John Fowler and Sir Benjamin Baker, and Mr. Greathead, Messrs. S. Pearson & Son were entrusted with a contract for carrying on the work, some fresh capital having been raised in England; and I represented them upon the works. The shield, which weighed about 80 tons, was put together 2,000 feet out from the Jersey shore of the river, under a pressure of over 35 lbs. per square inch above the atmosphere. It was a very difficult job, having to be rivetted up by unskilled men, but it was ultimately got to work, and made good progress until financial difficulties again beset the company. During the twelve months that the shield was working, however, nearly 1,900 feet were constructed under an air pressure of 30 lbs., and as much as 72 feet of completed tunnel were fixed in one week. Out of 5,500 feet in all, there only now remain some 1,600 feet to complete to make a connection between New York and Jersey City, and there is no doubt that money will be forthcoming some day to finish this work, which cannot fail to be an important connecting link between New York and the mainland, from whence nearly all the main western trunk lines start."

The Rapid Evolution of Engineering.

PRESIDENT THOMAS CURTIS CLARKE'S address before the annual convention of the American Society of Civil Engineers at San Francisco, on June 30, is full of excellent things, clean, telling, epigrammatic, and forms a striking exposition of the dignity of the profession and its integral relation to the progress of the world, both in practical and intellectual matters.

The essential characteristic of the engineer he considers to be the scientific habit of observation, deduction, and experiment. Exercised *per se* in the natural world, the resultant would be discovery, pure and simple; combined with the conception of adaptation to human needs, it becomes creative. The engineer may not necessarily be an investigator, but he must be quick to understand the investigator's work, and interpret it in terms of useful application and practical service.

Mr. Clarke, in a brief summary, suggests the many highly-specialized branches into which the profession is now divided. Apart from military engineering, he distinguishes "structural, mechanical, electrical, metallurgical, hydraulic, mining, agricultural, chemical, sanitary, municipal, highway, and railway engineering. These classes are again subdivided; as hydraulic engineering into canal, harbor, water-supply, power, storage, and irrigation engineering; or railway engineering into bridge, foundation, track, signaling, locomotive, and car engineering." All these Mr. Clarke would include under the one general head of civil engineering, abandoning the restricted and at the same time indefinite sense in which this term is generally understood, and returning to the primary sense which it bore when the entire profession had but two departments, —"Military" and "Civil."

This almost overwhelming catalogue suggests the rapid expansion and specialization which has taken place under the influence of modern tendencies, and the radical change involved to older members as well as to those just entering the work. We have been passing through an era of extraordinarily rapid change, no doubt often bearing hard upon those whose lack of equipment or of adaptiveness prevents them from continuously adjusting themselves to a rapidly-changing environment.

Like many other lines, engineering is becoming "commercialized" as well as specialized. Much of the work which formerly sought the individual now goes to large construction companies; but the in-

creased facilities and economies attending the new method lead to more and larger undertakings. And the net result is a demand for still higher skill and more workers. Railroad construction may diminish, but railway operation absorbs even more engineering talent for its maintenance of way, its shops, its signals, and its superintendence. The final settlement of boundaries takes away the occupation of the once important surveyor, but the growing municipality requires a score for its public works and private buildings.

And the end is not yet,—nay, this is but the beginning. The tendency of the future will be steadily toward a broader and more diversified extension of the work of the engineer. The profession has better openings now than it ever had before, but he who builds his career within its lines must lay his foundations broad and deep, so that there may be room to erect safely upon them a structure which may require unexpected modification in the building. There is much short-sighted criticism of engineering schools for amplifying their courses with studies of which the impatient "special student" does not see the value in relation to his chosen branch of work, simply because, as a rule, neither he or the critics who join with him have had experience to teach them how inextricably the applied sciences are interwoven, and how many things ought to be somewhat familiar even to the close specialist.

The engineer, above all, must realize the definition of a gentleman (Lord Chesterfield's, was it not?) and know "something of everything, and everything about something." The graduate's path often takes an unexpected turning, and an elective or optional study may become unexpectedly important in his after career.

Japanese Marine.

AN extract from the Japanese *Weekly Mail*, reprinted in the *Board of Trade Journal* (London), presents the views of the ex-chief of the Japanese ship-control bureau, as given by him in a recent lecture before the Toho Kyokai (Oriental Association), upon the Japanese navigation encouragement bill, which has followed the action of the Tokyo chamber of commerce mentioned on page 144, current volume. On the whole, he gives the bill a general approval, but criticises it in certain respects. He thinks a distinction in the matter of subsidy ought to have been made between foreign-built vessels and those built in Japanese dockyards, and that provision ought to have been made for home competition.

Reference to the review on page 144 will show that the board of trade desired that Japanese shipbuilders should be subsidized, and that subsidized yards should be favored.

He is not content with present facilities for the training of officers and sailors, which he regards as inadequate. Nevertheless, he believes that the result of the enactment of various navigation laws, some of which have secured the approval of the diet, and the subsequent expansion of Japan's maritime business, will be to affect the resources of Hong Kong: a gradual transference of the right of coasting in China and Japan will follow, and regular services to the South Seas will afterwards be undertaken by Japan. He believes Japan's greatest commercial centre will be Tokyo, and he cannot but marvel that the citizens are apparently indifferent to the important question of the reconstruction of the harbor of that city.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

6555. The South Rocky River Bridge (Illustrated description of a high level viaduct built near Cleveland, O., which shows quite a departure from the usual style. Special pains was taken to secure an improvement from an architectural standpoint). Eng Rec-June 13. 1500 w.

*6588. Railway Bridges for Branch Lines. M. A. Pollard-Urquhart (Read at meeting of Soc. of Engs., London. Deals with public road bridges over the railway, public road bridges

We supply copies of these articles. See introductory.

under the railway, bridges for occupation roads, and bridges over water courses). Arch, Lond–June 5. 2500 w.

†6647. The Strain Sheet and Estimate of Cost for a Pratt Truss Highway Bridge. A. B. Loomis (Assumed data are given for the case under consideration, with determination of weight or dead load, calculation of stresses, estimate of material and estimate of cost). Tech–May, '96. 1700 w.

†6667. The North River Bridge. G. Lindenthal (Illustrated description of the general technical features of the undertaking. The characteristics of the superstructure, foundations, peculiarities of end spans, method of erection, and comparison with other large bridges). Trans Assn of Civ Engs of Cornell Univ–June, '96. 4900 w.

*6695. The New Bridge Over the Seine (A somewhat minute description of the Mirabeau Bridge. It possesses many features of originality in its details). Engng–June 12. Serial. 1st part. 2200 w.

6968. Rock River and Merrimac Bridges, Chicago & Northwestern Ry. (Illustrations and description of the essential features of interest to engineers of the two bridges recently completed by this road to replace old bridges. (Eng News–July 9. 1600 w.

Canals, Rivers, and Harbors.

6522. The Dry Dock at Kingston, Ont. Henry F. Perley (Read before the Canadian Soc. of Civ. Engs. Illustrated description). Can Eng–June. 2500 w.

†6662. The Kampsville Dam. S. T. Morse (Illustrated description of the location, design and construction, with time, cost and durability statement). Tech–May, '96. 1700 w.

†6663. The Transportation of Solid Matter by Rivers. William Starling (An interesting study of this subject, giving theories of noted writers). Trans Assn of Civ Engs of Cornell Univ–June, '96. 9000 w.

†6664. Description of a Break on the Erie Canal. Albert J. Hymes (The large break that occurred at Pattersonville, ten miles west of Schenectady, on June 5, 1895. The cause supposed to be some defect in the culvert. The construction of such culverts is illustrated and described). Trans Assn of Civ Engs of Cornell Univ–June, '96. 3000 w.

*6672. The River Indus and the Best Method of Embanking It. G. M. R. (Traces briefly the stages through which the river must have passed, and offers methods for improving its condition). Indian Forester–April. 10800 w.

Hydraulics.

†6671. On the Flow of Water in Branching Pipes. A. L. Colsten and R. H. Keays (Account of recent experimental researches made in the hydraulic laboratory of the College of Civil Engineering of Cornell University). Trans Assn of Civ Engs of Cornell Univ–June, '96. 1200 w.

†6866. The Hydrology of the Mississippi. James L. Greenleaf (A brief but interesting discussion from the point of view of the engineer, based upon a report made by the author in the tenth census of the United States. Sixteen branches of the Mississippi are considered, and diagrams and tables accompany the discussion). Am Jour of Sci–July. 5500 w.

Irrigation.

†6650. Flow of Water Through Siphons. Milo S. Ketchum (Account of experimental researches made in the laboratory of applied mechanics in the Univ. of Illinois, with tabulated data and engraving of apparatus employed). Tech–May, '96. 1700 w.

†6811. The Stepchild of the Republic. William E. Smythe (A discussion setting forth the importance of Arid America, its size and character. The Carey law and what it has done and will do for the situation. Steps necessary for the final solution of the problem). N Am Rev–July. 3800 w.

*6554. The Admixture of Kentish Ragstone With Portland Cement (The report of Dr. W. Michaelis, Berlin, to the London Chamber of Commerce, interesting as being an additional proof of the fallacy of deductions drawn from tests of neat cement). Engng–June 5. 1400 w.

*6571. The Design of Derricks. Benjamin F. La Rue (The object of the article is to explain how the stresses may be accurately computed and the material properly proportioned for the ordinary boom derrick). Stone–June. 2500 w.

†6653. An Investigation of the Relative Strength of Hydraulic Cements. H. C. Estee (Investigations based on data of reports of tests made by about twenty city engineers and by several cement dealers. A table gives the average strength of each class at various ages). Tech–May, '96. 1000 w.

†6654. The Effect of Grinding Mixed Sand and Cement. H. E. Reeves (A summary of results of a series of experiments undertaken in the Cement Laboratory of the University of Illinois). Tech–May, '96. 800 w.

†6666. Holland's War With the Sea. J. H. Gore (A discussion of the conditions under which this annex to the continent was made, the technical processes employed by the people to keep back the waters, and its effect upon the character of the people. A very interesting paper). Trans Assn of Civ Engs of Cornell Univ–June, '96. 8000 w.

6765. Transverse Tests of Beams of Oregon Pine (Douglas Fir) (Letter from William Hood, chief engineer of the Southern Pacific Co., with a memorandum concerning transverse tests of 60 beams of Oregon pine, and a table giving a summary of results and figures of moduli of elasticity and fibre stress). Eng News–June 25. 2000 w.

6890. Cement from Blast Furnace Slag (Account of a series of experiments made at the North Works of the Illinois Steel Co. in Chicago, which lead to the conclusion that this cement, like the Roman, will stand the test of time. The conditions which form the basis of this conclusion are given, the process described and a statement of practical results). Ry Rev–July 4. 1400 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Reduction of Relay Resistance in Telegraphy.

COMPARATIVELY recent changes in telegraphic practice are neither few or unimportant, though the remarkable advances in other and newer fields of electrical engineering have diverted public attention from the quiet progress constantly made in the older art. This progress and personal experience furnish themes for an interesting, though rather short, paper read by Mr. U. J. Fry before the June meeting of the Association of Railway Telegraph Superintendents, reported in *Electrical Review* (June 24).

The earlier practice began with relays of much less resistance than have since been employed. From 100 to 150 ohms the resistance was increased to 225, 350, 400, and, in some cases, 500 ohms, 400 ohms, as Mr. Fry states. having been thought the proper thing on the road where he was first employed. But there was also great want of uniformity in the resistance of different relays used on the same line. Uniform resistance in relays gave good results, except in foggy and rainv weather. When Mr. Fry came to the road where he is now engaged, a uniform resistance of 150 ohms had just been adopted. To meet the difficulties experienced in wet weather, he first inspected the insulation carefully, and, finding it good, turned his attention to other means of improvement. What was wanted was a reduction of resistance in the circuits, and this was accomplished by the substitution of multiple relays for series relays, the substituted relays having a resistance of 37½ ohms instead of 150; and he also employed wire in which the resistance of the circuit did not exceed that of the instrument.

"The circuit chosen was a Milwaukee to Oshkosh No. 8 gage wire, 104 miles in length, measuring about 15 ohms per mile, or 1,500 ohms, with 35 relays in circuit; relay resistance, 5,270; total, 6,810. After replacing the old with the low-resistance relays, we found the total resistance to be 2,872,—a difference of 3,938, or the amount of relay resistance taken out. We then reduced our batteries from 150 to 75 cells. After working this wire for six months in this way, we noted the following comparisons: prior to the change, the wire did not work in the best of weather satisfactorily, and in foggy and rainy weather very unsatisfactorily, and at times we were unable to work more than half way. The current in bad weather fluctuated so that it was impossible for the operators to keep their instruments adjusted. After the change, the wire worked perfectly in any kind of weather."

Mr. Fry says, with reference to the extension of the system to other circuits, that he has not reached perfection in all the circuits on the road, the conditions not being the same; but he makes the following interesting statement:

"We have seven circuits arranged in this manner. We are doing business right along, irrespective of the condition of the weather. One of our circuits, 200 miles in length, equipped with this class of instruments, did not at first give us the desired results, and we were considerably annoyed in bad weather. We placed a 50-cell battery in the middle of this wire, which resulted in a decided improvement. While this circuit may not work quite as well as shorter ones arranged in this manner, it has improved it wonderfully; so much so, that our dispatchers are able to handle trains in all kinds of weather, without delay.

"Prior to the change, our Chicago to Savannah dispatchers' wire, 138 miles in length, worked so badly in rainy weather that at times we were unable to work with Elgin, a station 35 miles out of Chicago. This circuit was a new No. 8 gage iron wire, new line of poles, insulation as perfect as glass could make it. After we changed to the lower resistance instruments, our dispatchers were able to work the wire its entire length with about the same degree of rapidity in rainy weather as in dry weather. Without having tried, it is our opinion, however, that, if we should equip this circuit with 25-ohm relays, and place a battery of, say, 30 to 50 cells in the middle, we would secure still better results.

"We have been experimenting with a 25-ohm relay on one 200-mile circuit, and are meeting with exceptionally good results. We find that, during a thunder and lightning storm, this relay performs much better than the 150-ohm relay. When it is affected by lightning, it discharges so quickly that it obliterates only a letter or two, instead of a word or two, as is the case with the old instruments. We expect to equip the entire circuit with 25-ohm relays in the near future. We do not wish to be understood as claiming that 25 ohms is the proper resistance; but we have met with such encouraging results that we are going to give them a trial."

This experience is decidedly favorable to the use of low-resistance relays, and doubtless will lead other railway superintendents to experiment in reducing circuit resistance. No application of telegraphy can be of greater importance than railroad work, and in no other use are interruptions of communication of such inconvenience and even danger.

Insulation of Grooved Armatures.

THE difficulties that have been experienced in insulating grooved armatures, and which have, in some measure, deterred manufacturers from using them, are held by Mr. William Baxter, Jr., in *American Machinist* (June 11), to be not as formidable as has been imagined. It simply requires a recognition of what are really the weak points, and a knowledge of the requirements for their protection, to enable manufacturers to overcome all the difficulties, and to make the insulation as substantial and permanent with the grooved type as with the smooth core; and this without materially increasing the cost of construction.

A U-shaped piece or trough of mica accurately fitting the groove for machines working with an electro-motive force of more than one hundred and ten volts, and of proper thickness, is the best insulator for the sides and bottoms of the grooves. Sheet fiber rendered water-proof by saturation with paraffine will, however, answer well for machines used in buildings. The mica troughs can be made of thin plates of mica stuck together with copal varnish, tempered with raw linseed oil to make it tough.

Other ways of using mica are described and illustrated in Mr. Baxter's article. He points out that the insulation is most likely to give out at the ends of the grooves, and presents a practical way of obviating this difficulty, closing with a statement of the necessary thicknesses of mica for machines working under different voltage.

An Electric Trevelyan Rocker.

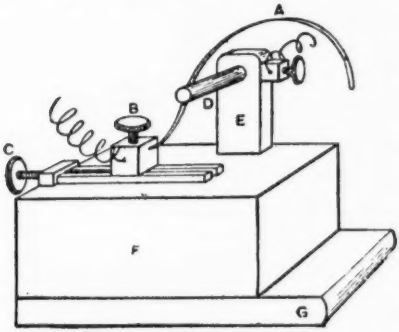
THE Trevelyan rocker is a well-known piece of physical apparatus used to demonstrate the intensification or increase of molecular motion in solids by sudden increase of temperature in contact points. A bar arranged to rock easily is placed upon another body in such manner that in rocking it rests alternately upon different small surfaces of contact. If one of the bodies has been heated, the sudden expansion of the alternate points of contact will react upon the rocker, and cause it to oscillate from one point of contact to the other in rapid succession. A similar phenomenon is sometimes observed when a flat-bottomed tea kettle filled with cold water is placed upon a heated range in such manner that it does not stand evenly and firmly. This action is explained with great clearness in Tyndall's lectures on

"Heat as a Mode of Motion," and is also described in many other text-books of physics.

The Electrical Engineer (June 24) has a reprint from the London *Electrician*, describing a curious electrical phenomenon, contributed to the last-named paper by Mr. T. A. Vaughton. This phenomenon occurs with an apparatus which Mr. Vaughton provisionally calls an electric Trevelyan rocker.

The arrangement of this apparatus is seen in the accompanying engraving.

A piece of watch-spring, A, curved into the shape shown, is fixed into the terminal, B. This terminal moves along a slide and



AN ELECTRICAL TREVELYAN ROCKER.

carries the spring with it, and, by means of the screw, C, the pressure of the spring against the metallic rod, D, is regulated. This rod is supported by a wooden support, E, and the whole is fixed upon the top of a wooden sounding-box, F, which has a projecting piece, G, by means of which it may be clamped down to the bench when in use. On regulating the pressure with which the spring presses against the rod, and the position on the spring of the point of contact, a point will be found on which the spring, when pulled on one side and released suddenly, will vibrate freely in a transverse direction. If, while the spring is thus vibrating, an electric current of definite strength be passed through the bar and down the spring, the vibrations will be maintained and a musical note will be given out, the pitch of which depends on the length of the free end of the spring. The temperature of the spring and rod gradually rises, until a point is reached at which the vibrations cease.

If the apparatus is immersed in water or alcohol just deep enough to cover the point of contact between the spring and rod, the vibrations take place as before, but the sound emitted is weaker. By placing a small split bullet in various positions on the free end of the spring, the rate of vibration may be varied and the amplitude increased, and, by fixing a small concave mirror upon the spring and reflecting a spot of light from it upon a screen, the vibrations may be magnified and observed.

The steel spring may be replaced by one of platinum or German silver, but in these cases the vibrations are more feeble. Rods of almost any hard metal may be used, but steel gives the best results, and is followed by iron, German silver, platinum, brass, gas carbon, aluminum, and nine-carat gold, in the order named.

Mr. Vaughton says he has not been able to obtain any sustained vibration with rods of copper, silver, tin, and lead, although even with these metals the dying away of the vibration appears to be considerably retarded by the passing of the current. No visible sparking takes place, and there seems to be no interruption of the current.

These phenomena appear to be the effects of the heat generated at the point of contact, although the fact of their taking place under water would at first sight seem to negative this assumption. Mr. Vaughton adds that he has failed to get any results with springs of good conducting metals, such as gold, silver, and copper.

Lord Kelvin and His Life-Work.

THE fiftieth anniversary of Lord Kelvin's professorship in Glasgow University has been made a general and welcome occasion for paying homage to his genius and character. Fifty years of honorable service in such a capacity during a period of entirely unprecedented scientific activity means a great deal. It means untiring zeal and physical ability to bear up under a con-

stant strain of hard work. No man, however gifted by nature, could have maintained the commanding position before the scientific world that Lord Kelvin has held during this period without labor that would have broken down the majority of men. The admiration his intellectual powers and other great qualities have excited is fully justified by his achievements. The literature and the appliances of scientific work have been enriched by his work, and on all departments of science the influence of his life and example has been far-reaching and enduring. It is fitting, therefore, that scientific and technical journals should review the results of such a life, and that those of his own land should dispose much space to the grateful task of recording his works.

In particular *The Electrician* (June 19) prints three separate and able articles, the titles of which are, respectively, "Lord Kelvin's Researches," "Lord Kelvin and Submarine Telegraphy," and "The Electrical Measuring Instruments of Lord Kelvin." These titles are significant of the phenomenally broad grasp of this veteran. Theory, practice, invention, the power to impart instruction (added to a singular power of original investigation), and unswerving devotion to science for its own sake, are all implied in these titles. And, when it is remembered that, having passed by more than a decade the threescore and ten years allotted to man, Lord Kelvin is still in harness with unimpaired intellect and physical health rare at his age,—that he is still at work and enjoying work,—we shall find it difficult to recall many lives that, in every respect, can be compared with his in its grand accomplishment.

Though his fame will rest mostly upon his work in the electrical field, it would be a mistake to suppose that this field has confined his powers. We see his name so frequently now in connection with electrical science that perhaps many have come to regard him as purely an electrician. *The Electrician* says:

"He has worked in the most diverse lines. With the whole gamut of applied mathematics at his finger-ends, he has applied it to the laying of telegraph cables and to calculate how best to signal through them; how best to compensate for the action of the iron in ships on their compasses, and how to predict the tides; how to measure temperature and electricity; how to calculate the age of the earth and the size of an atom. In each of these lines and in many others he has made important contributions to the sum of human knowledge, and has improved the opportunities of human activity.

"Lord Kelvin's mathematics is of the specially powerful type that distinguishes such giants as Laplace and Green. He is determined at all costs to solve the question, and does not give up because it leads to laborious approximations and complicated series. He rejoices no doubt in elegant methods, as, for example, in the theory of electrical images; but what some would consider inelegant and sledge-hammer methods are at hand to obtain the result. His mathematics is for the sake of the result, and not for the sake of the mathematics. He has especially developed the methods of physical investigation depending on the principles of the conservation of energy, and the popularity of these methods owes a great deal to his powerful example."

Hydrodynamics, thermodynamics, the theories of elasticity and of optics, have each been largely advanced by his labors. As an inventor he holds high rank. His method of rapid sea-sounding for use on ocean-going vessels is alone enough to establish this claim. His apparatus for sounding is now a standard appliance on ocean-going steamers. His siphon recorder would also be enough to establish the fame, as an inventor, of any man. But, having paid this tribute to the magnificent genius of one of the ablest of living electricians, we must leave the long enumeration of his noble achievements to others. The three articles named in this review will well repay perusal, as a record of what earnest, persevering work can accomplish in the short span of one human life. The honors paid to Lord Kelvin are made more brilliant by the modesty of their recipient.

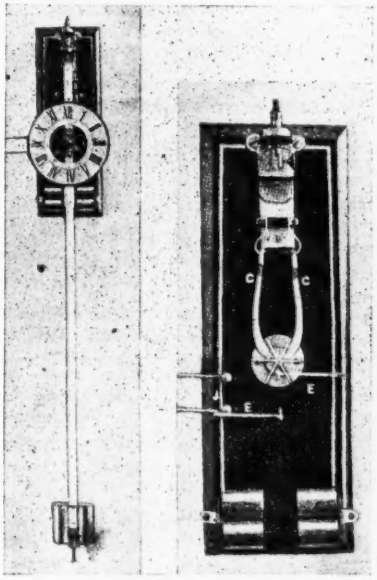
The Hayden Century Clock.

THE use of electricity in horology dates back well toward the general introduction of electric telegraphy. Among the first applications was the employment of an electric current and electro-magnets to control the movements of clocks, by thus connecting them with a master-clock sometimes at a long distance from the clocks regulated by it. Next, the master-clock was made, at each beat of its pendulum, to form an electric circuit, which moved hands on a distant dial, whereby the time indicated by the master-clock could be shown as well on the remote dial as on its own dial. It was but a step from this to the substitution of electric power for the weights or springs previously used for actuating clock-works, and which required periodical winding. However, comparatively little has yet been done in driving clocks by electricity. An example of such a clock, described and illustrated in *The Electrical Engineer* (May 27), has been designed and constructed in Trinity College, Durham, N. C., by Mr. J. F. Hayden. The current for this clock is derived entirely from an earth battery having a quantity of old furnace grate-bars for one electrode, and a mass of coke for the other, both buried in the earth near the building in which the clock has been placed. It is expected that this battery will supply the power needed for a period of from fifty to one hundred years, and this has probably suggested the name used as the title of this review and of the description given in *The Electrical Engineer*, of which the following is a condensation.

The pendulum, which is also the driver, has a wooden shaft, and heavy cylindrical weights for the bob, and is suspended from the bracket attached to the back-boards (Figs. 1 and 2). An automatic switch, C G, sends the current around first one and then the other of the electromagnets, D and H. The screw, A, at the upper end of the pendulum is electrically connected to the upper binding post, J, and also to two contact points, one on each side of the shaft at L. The arms, C and G, of the automatic switch are insulated from each other. The upper arm, G, is in metallic connection, through the central screw, with a wire in the rear of the back-boards, leading to the coils about the pair of magnets, H. The lower arm, C, rests on the brass plate, F, the latter being connected with the coils about the magnets, D.

As the pendulum swings, the current alternately passes around the two pairs of electromagnets, D and H, and the two soft-iron armatures at I are alternately attracted.

Starting from the upper of the binding posts, J, the current passes to A, then through the piece of sheet steel, B, attached to the upper end of the pendulum shaft, to the contact points, L. When the pendulum starts from the magnets, H, towards the magnets, D, the contact is made from L through C, and the current will pass around magnets D, and from there to the lower binding post, completing the circuit through the battery. This aids the force of gravity in carrying the pendulum towards D. When the pendulum starts back from D, the contact is made with G, and the current passes around the magnets, H, giving the pendulum a pull in that direction. If these pulls at



THE HAYDEN CENTURY CLOCK.

each stroke of the pendulum are sufficient to overcome the loss by friction of the moving parts, it will continue to vibrate.

To regulate the amount of current passing to the electromagnets, two brass tips are affixed to the shaft at K, their distance apart being readily adjusted by screws. Shortly after the contact is made with C, as the pendulum swings toward D, the connection is broken by the arm, C, coming in contact with the strip, K, on that side, and, if the current is very strong, the strip will push the switch far enough to throw G into contact, and the current will pass around the magnets H. The latter action will tend to retard the motion of the pendulum toward D. By adjusting the distance between these strips, almost any current may be used to run the clock.

The works and dial are placed upon the pendulum and swing with it. The seconds hand is attached to a ratchet wheel having sixty teeth, and is actuated at each stroke of the pendulum by the pawls, E E, which are attached to the back-board. The motion is communicated to the minute and hour hands by the usual intermediate wheels. The movement is jeweled, and the pawls have steel tips. The tips of the pawls work in semicircular grooves in such a manner as to make it impossible for them to catch more than one tooth at each stroke of the pendulum. The length of pendulum is adjustable both at the upper and at the lower end by means of suitable screws.

The lower end of the pendulum is provided with two needle points fixed in the nut, n. These pass simultaneously through two drops of mercury, each of which is in metallic connection with one of the binding posts at the right-hand lower side of the case. Thus we have a clock that may be used in many laboratory experiments where a seconds pendulum is required. A local circuit may be closed through an electric bell or telegraph sounder at each stroke of the pendulum.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*6510. A Practical Exposition of Electric l ighting. Wm. A. Anthony (An elaborate review of Prof. Crocker's recent book). Eng Mag–July. 3800 w.

6845. Municipal Ownership of Electric Plants (Editorial on the subject referring to paper of Allen R. Foote, read at the Street Lighting Convention in New Haven). Elec Eng–July 1. 1400 w.

6895. Electric Street Lighting. M. J. Francisco (Statements and arguments from a business standpoint. Reports and figures are from a personal examination of plants. Favors private ownership). Pro Age–July 1. 5000 w.

*6905. Lighting Country Residences and Institutions. Henry Stooke (A description of the Scott-Sisling system). Ill Car & Build–June 26. 1000 w.

6950. Alternating-Current Stations and High Voltage Lamps. H. W. Couzens (Read before Municipal Elec. Assn., England, a brief consideration of the subject, with discussion). Elec Rev–July 8. 2500 w.

6956. On the Cause of Continuous Spectra in Exhausted Tubes. W. H. Birchmore (A speculation as to its possible origin, with description of phenomena). Elec Eng–July 8. 2700 w.

6957. Some Central Station Economies. P. G. Gossler (Abstract of a paper read before the Canadian Elec. Assn. Results obtained from the partial reconstruction of a plant). Elec Eng–July 8. 3500 w.

6963. Some Faults in Arc-Lamp Carbons. W. M. Stine (Points relating to arc-lamps and especially arc light carbons which should be considered by manufacturers). Elec Wld–July 11. 1200 w.

6964. Electric Lighting on the Steamer "Adirondack" (Illustrated description). Elec Wld–July 11. 800 w.

Power.

6521. Electricity from the Wind. E. O. Baldwin (Abstracts from a paper read before the Netherlands Society for the Promotion of Industry, Haarlem, Holland. Refers to unsuccessful undertakings and describes a successful system). Can Eng–June. Serial. 1st part. 3500 w.

6573. The Total Efficiency of Certain Central Stations. E. A. Merrill (A survey of the subject from the stand point of actual practice). Elec Engng–June. 2400 w.

*6593. Electrical Equipment for Mines (Brief directions of points that should have attention in the introduction of this form of power, with estimates of approximate cost, motors used, and recent improvements). Ir & Coal Trds Rev–June 5. 2800 w.

*6603. Phenomena of Commutator Resis-

We supply copies of these articles. See introductory.

tance. H. J. Edsall and M. C. Rorty (Experimental study of brush contact resistance with summary of results). Sib Jour of Engng–June. 1100 w.

*6606. A Study of a Three-Phase Motor. C. W. Van Law and H. S. Simpson (An abstract of a test of power measurement, etc., conducted in the laboratories of Sibley College). Sib Jour of Engng–June. 2000 w.

*6608. The Sibley College Multi-Phase Generators. L. A. Murray and H. H. Norris (Machines are described). Sib Jour of Engng–June. 900 w.

6609. Electric Lighting, Heating and Power Plant of the New Boston & Maine and Fitchburg Union Station, Boston (Illustrated description). Safety V–June. 3300 w.

6617. How to Get Different Kinds of Currents in a Cheap and Simple Way for Experimental Work. F. Jarvis Patten (An article prepared in the hope of making clear to those who do not possess sufficient theoretical knowledge to work unaided, how the different kinds of current may be obtained from a direct current). Am Elect'n–June. 1400 w.

6619. Methods of Starting Induction Motors, P. M. Heldt (A review of the different methods). Am Elect'n–June. 1200 w.

6639. The Action of the Shunt Motor. William Baxter, Jr. (Explanation of the principles upon which the close regulation of speed in shunt-wound motors depend). Am Mach–June 18. 1300 w.

6643. Electro-Aerostatics. S. D. Mott (Illustrated description of machines for scientific investigations, and other uses). Elec Wld–June 20. 2200 w.

6644. The Mistakes That May Be Made in Consequence of the Prevailing Tendency to Reduce the Speed of Electrical Machinery. William Baxter, Jr. (A review of the subject in its various applications). Elec Wld–June 20. 1900 w.

†6651. Alternate Current Motors. Bernard V. Swenson (Descriptive of the different varieties of alternate current motors). Tech–May, '96. 4200 w.

†6652. The Alternate Current Transformer. J. D. Morse and J. E. Pfeffer (Description of researches with table of principal observations and calculations, and diagrams). Tech–May, '96. 5000 w.

*6697. An Interesting Electric Power and Light Plant (An extract from circular issued by the Electric Company, Limited, of London, describing some of the more special features of the electric power and light plant constructed at the free docks of Copenhagen). Prac Eng–June 12. 2800 w.

*6719. Wolverhampton Electric Supply System (Illustrated description). Elect'n–June 12. 4000 w.

6732. Electric Light and Power on a Railway Dock. H. C. Hope (Read before the Assn. of Ry. Telegraph Supts. Equipment of the dock C., St. P., M. & O. Ry. at Itasca, Wis). Elec Rev–June 24. 500 w.

6749. The Care of Commutators. Charles Wirt (The tendency of commutators to develop flat spots, similar to wear of car-wheels, and showing that this is not necessarily due to faulty construction, with suggestions for treatment). Am Mach–June 25. 1000 w.

6750. Electrical Tests of Power Consumed by Rolling-Mill Machinery. Reported by E. H. Wise, Electrician of the Cambria Iron Co. (Tests of lathes, saw, presses, punch for rails, traveling crane, etc). Am Mach–June 25. 1400 w.

*6757. The Power of Water. C. A. Stone (The power going to waste in our streams, and the conditions under which electric transmission can be used to advantage). Milling–June. 1100 w.

6772. An Experimental Study of Electro-Motive Forces Induced on Breaking a Circuit. F. J. A. McKittrick. With an introduction by Edward L. Nichols (An attempt to describe the results of an introductory experimental study of the induction phenomena exhibited when the circuit is broken. The article was read at the general meeting of the Am. Inst. of Elec. Engs). Elec Wld–June 27. Serial. 1st part. 2400 w.

*6776. Electricity Supply at 220 Volts. A. S. Barnard (A summary of the chief points of a paper read at the Convention of the Municipal Electrical Assn). Eng, Lond–June 19. 1400 w.

*6780. Use of Electricity on Board Ships. F. Eickenradt (Read at meeting of the Inst. of Naval Architects. The subject is treated from the point of view of the shipbuilder. Lighting, ventilation, heating, gun and turret turning, winches, hoists or lifts, etc., are considered). Eng, Lond–June 19. 4000 w.

*6791. The Langdon-Davies Alternate Current Motor. Ill. (Description of a machine in which such improvements have been made in the magnetic arrangements, that the motor has an efficiency, according to Dr. Thompson's report, of 91% at its maximum power, and also at half-power, while between these limits it rises to 95%). Engng–June 19. 2800 w.

*6820. The Principles of Alternate-Current Working. Alfred Hay (Based on a series of evening lectures delivered at the University College, Liverpool. The subject is treated in a manner adapted to the comprehension of students). Elec Eng, Lond–June 19. Serial. 1st part. 2400 w.

6841. Power Plant of the City and Suburban Railway Co., Baltimore, Md. (Illustrated description). Power–July. 3500 w.

6846. On the Seat of the Electrodynamic Force in Ironclad Armatures. Ill. Edwin J. Houston and A. E. Kennelly (The authors have experimentally demonstrated that in the type of armature employed by them more than 98% of the entire torque was exerted on the iron, less than 2% being produced by the conductors). Elec Wld–July 4. 1600 w.

6847. The Baltic Taftville Transmission Plant. H. E. Raymond (Illustrated description). Elec Wld–July 4. 3000 w.

6852. The Thirty-five-mile Electrical Power Transmission of Fresno, Cal. (Illustrated description of a recently completed work. The distance is the longest yet attempted for the

electrical transmission of power generated by an artificial fall of water). Lord's Mag–July. 1400 w.

*6925. The Langdon-Davies Self Starting Mono-Phase Induction Motor (Illustrated description). Elec Rev, Lond–June 26. 1800 w.

*6926. Electrical Transmission in Spain (Description with illustrations of an interesting system recently put down by Messrs. Siemens Bros. to supply light and power to Alcoy and Gandia, two towns in Valencia. The power is from the Serpio, a river running between a range of mountains, but having no natural fall). Elec Rev, Lond–June 26. 900 w.

*6936. Combined Electric Lighting and Traction Plants. John Hesketh and John H. Rider (Read before the Municipal Elec. Assn. Way in which electrical supply may be cheapened by judicious foresight and application of present knowledge). Ind & Ir–June 26. 2500 w.

6951. Electricity Supply at Two Hundred and Twenty Volts. A. S. Barnard (Read before the Municipal Elec. Assn., England. Deals with the advantages and disadvantages of the use of 220 volts on the distributing mains). Elec Rev–July 8. Serial. 1st part. 2300 w.

6965. The Storage Battery for Fire-Alarm and Police-Telegraph Purposes. John L. Hall (Explanation of the new installation which the writer has just completed for the fire alarm and police telegraph of Wilmington, Del., with illustrations). Elec Wld–July 11. 700 w.

Telephony and Telegraphy.

6529. The Storage Battery in Telegraph Work. Maurice Barnett (The almost ideal application of storage batteries for telegraph and telephone stations, fire alarm, police telegraph, burglar-alarm, and heat regulating systems. A discussion of their adaptation for this kind of work). Elec Wld–June 13. Serial. 1st part. 2400 w.

*6544. Professor Elisha Gray's Telautograph (Illustrated description). Eng, Lond–June 5. 1600 w.

6731. The New York Telephone Company (A new organization with sixteen million dollars capital). Elec Rev–June 24. 400 w.

6733. Reduction of Relay Resistance. U. J. Fry (Read before the Assn. of Ry. Telegraph Supts. The experience of the writer). Elec Rev–June 24. 1200 w.

*6804. Lord Kelvin and Submarine Telegraphy. Arthur Dearlove (A review of his work in this field showing the range of his influence on the working, testing and laying of submarine cables). Elect'n–June 19. 1700 w.

6823. Machine Shop Practice in the Manufacture of Commutators. E. L. Hayward (The object of the article is to suggest a few methods which have stood the test of practice in commutator building, and to describe the simple tools employed). Am Mach–July 2. Serial. 1st part. 1500 w.

6829. The Action of the Differentially-Wound Motor. William Baxter, Jr. (An instructive study). Am Mach–July 2. 1200 w.

6843. The Home Telephone Company's System, Mobile, Ala. (Illustrated description of an independent company, whose equipment is radically different from those generally seen. The instruments and appliances used are described in detail). Elec Eng–July 1. 4000 w.

6850. Educating Operators in the Handling of the Switchboard. W. E. Packard (Read before the Assn. of Ry. Telegraph Supts. Commenting on the inefficiency of operators and suggesting improvement). Elec Rev–July 1. 1100 w.

6854. The Berliner Controversy. W. Clyde Jones (A statement and discussion of the case). Elec Engng–July. 3800 w.

*6923. The Telephone at the Springhill Infirmary, Birmingham, Eng. (Illustrated description of a system laid down to prevent loss of time in calling medical aid to any part of the institution). Elect'n–June 26. 500 w.

6960. Inductance as a Negative Capacity in Submarine Cables. A. Davidson (Experiments, to exhibit the value of inductance as a negative capacity, made on a length of submarine cable of modern type, armored with steel wires and coiled in an iron tank). Elec Eng–July 8. 350 w.

Miscellany.

*6507. The Direct Production of Electricity from Coal. Ill. George Herbert Stockbridge (A discussion of the carbon-consuming electrical furnace invented by Dr. W. W. Jacques, and of previous experiments of other investigators). Eng Mag–July. 3200 w.

6517. Notes on Electrical Engineering Drawing. J. H. C. B. (The first part of a serial on this subject with the object of comparing some of the divergent methods and endeavoring to select the most useful). Elec, Lond–May 22. Serial. 1st part. 1000 w.

6519. A Method of Increasing the Striking Distance of a Given E. M. F. (A letter from C. E. Skinner describing interesting phenomenon observed while experimenting with high tension apparatus, which he concluded would be useful in the construction of lightning arresters. Also, letter from A. J. Wurts giving experiments and analysis of phenomenon). Elec Eng–June 10. 1900 w.

6525. How to Insulate Grooved Armatures. William Baxter, Jr. (An article showing that the insulation can be made just as substantial and permanent with the grooved type as with the smooth core, and without any material increase in cost of construction). Am Mach–June 11. 1700 w.

6527. On the Influence of Light upon the Character of the Influence Machine Discharge. J. Elster and H. Geitel (From Wied. Ann. Report upon results of experiments). Elec–June 10. 1800 w.

6528. Notes on Electrical Consonance. A. W. Chapman (Results showing the effect of capacity in the secondary of a transformer, and that the primary current may be made to lead its E. M. F. for only a limited range of capacities in the secondary). Elec Wld–June 15. 1200 w.

6578. The Electrolysis of Chlorides. E. Andreoli (Referring only to those electricians who have successfully worked their processes on a commercial scale, and who have erected electro-chemical works capable of turning out daily one or two tons of soda and chlorine, or several tons of chloride of lime). Eng & Min Jour-June 13. Serial. 1st part. 2500 w.

*6584. A Simple Method of Analyzing Periodic Curves. E. Basil Wedmore (Paper read at a students' meeting of the Inst. of Elec. Engs. The writer enunciates the principle, gives examples of its application, and proves the method analytically and geometrically). Elec Eng, Lond-June 5. 4000 w.

*6586. Computations for Coil Winding. W. Slingo and A. Brooker (A review of the points involved, with account of experiments). Elec Rev, Lond-June 5. Serial. 1st part. 1800 w.

6616. The Edison Laboratory (Illustrated description of the buildings, materials, apparatus, and work, with brief description of Mr. Edison). Am Elect'n-June. 3000 w.

6636. A Day with the Founders of Ampere. T. C. Martin (Illustrated description of the Crocker-Wheeler Electric Co. with historical account of the enterprise). Elec Eng-June 17. 6400 w.

6642. Lord Kelvin (Interesting biographical sketch of this master in science). Elec Wld-June 20. 1600 w.

*6698. The National Electrical Exhibition at New York (Illustrated description of exhibits with comments). Eng, Lond-June 12. 4500 w.

*6702. Municipal Electrical Association (Presidential address of Arthur Wright before this recently organized technical society). Eng, Lond-June 12. 4000 w.

*6714. The Cost of Electric Energy in 1895. A. P. Haslam (Estimate of the progress of the industry. The results are classified and tabulated). Elec, Lond-May 29. Serial. 1st part. 1200 w.

*6720. The Electrolytic Dissolution and Deposition of Carbon (Editorial on the articles written by Prof Vogel and Dr. Coehn, with the substance of Dr. Coehn's last article). Elect'n-June 12. 1600 w.

*6729. Do Magnet Poles Emit Light Rays? Magnes (The writer endeavors to condense in as comprehensive a form as possible an investigation as extraordinary as fascinating, and one in which the great Swedish philosopher, Berzelius, took the deepest interest). Ind & Ir-June 5. Serial. 1st part. 2400 w.

6770. An Apparatus for Determining Induction and Hysteresis Curves. Frank Holden (Illustrated description of an instrument built by the writer over a year ago, with description also of method of getting the hysteresis curve). Elec Wld-June 27. 1000 w.

*6802. Electrical Communication with Lighthouses and Light Vessels (Review of the reports of the Royal Commission on the work accomplished, with references to recent papers bearing upon this subject). Elec Rev, Lond-June 19. 3800 w.

*6803. Lord Kelvin's Researches. G. F. F. G. (A summary of his work and its benefits). Elect'n-June 19. 5000 w.

*6805. The Electrical Measuring Instruments of Lord Kelvin. J. Rennie (The practical side of Lord Kelvin's work. The investigations suited to the needs of the workman and the instruments by which these methods could be conveniently applied. His opportunities as a teacher and the lasting effect of his influence). Elect'n-June 19. 3800 w.

†6831. Photographing Electrical Discharges. Walter E. Woodbury (Illustrated description of interesting examples). Pop Sci M-July. 1200 w.

6849. The Course of Bullets Changed by Electric Currents (Account of a curious phenomenon recently observed by the committee of the Swiss Federal Rifle Meeting at Winterthur, with results of experiments). Elec Rev-July 1. 700 w.

†6900. The Transformation of the Energy of Carbon into Other Available Forms. C. J. Reed (A discussion of the subject, and a consideration of the five general methods or processes known at present, for converting this form of energy into forms directly available to man). Jour Fr Inst-July. 8000 w.

*6906. Lord Kelvin's Jubilee. A. Gray (An interesting and complete account of this successful festival, with lists of delegates and visitors, letters and addresses). Nature-June 25. 13500 w.

*6921. Chemical Effects of the Electric Current. Reginald Gordon (Lecture delivered before the Henry Electric Club. Brief mention o the various ways the chemical effects of elecf tric currents are being utilized). Elec Pow-July. 2400 w.

*6924. The Control by Municipal Authorities of Consuming Devices and the Wire Connecting Them to the Mains. C. H. Wordingham (Paper read before the Municipal Elec. Assn. Points in connection with the question which are of importance to municipalities in possession of electric supply stations). Elect'n-June 26. 5000 w.

*6933. Thermo-Electric Reactions and Currents between Metals in Fused Salts. Thomas Andrews (Results of extended experimental inquiries by the author on this subject). Ind & Ir-June 26. 2800 w.

*6935. Cost of Electricity Supply. Arthur Wright (Read before the Municipal Elec. Assn. A description of the modifications of method, and the results of analyzing by them the figures obtained from the central supply station of the Brighton Corporation). Ind & Ir-June 26. Serial. 1st part. 3200 w.

6958. Electric and Magnetic Research at Low Temperatures. J. A. Fleming (A discourse delivered at the Royal Inst. Description of the latest results in the department of low-temperature investigations). Elec Eng-July 8. 2500 w.

6966. Effect of Temperature on Insulating Materials. Charles F. Scott (Statement of results obtained by Mr. C. E. Skinner in his work in this line). Elec Wld-July 11. 1300 w.

INDUSTRIAL SOCIOLOGY

Sound Money the Safeguard of Labor.

THE clamor of the silverites at the present time seems to sober economists so utterly senseless that any explanation of it, except such as would suffice to explain the dancing mania of the middle ages, seems inadequate. The arithmetic of the subject seems so simple and so easily comprehended; the precedents of depreciated money are so plentiful in history, and the effects of such money upon industry and commerce have been so uniformly disastrous in the past,—that, were it not a fact that an aged and experienced statesman left the party to which he has belonged and which he has served many years simply because it declared against silver in the St. Louis convention, the possibility that a man of this character, in his sober senses, could so act would be almost incredible; while that he could be the leader of a party bolt based entirely upon such a contention is yet harder to comprehend. That these bolters are, for the most part, sincere in their advocacy of silver is not doubted; the puzzle is to fix upon the quality of mind that can ignore the plainest logic and persistently hold the views advocated by them.

If a farmer had cattle to feed, and had corn and potatoes to feed them with, and if corn were worth twice as much as potatoes as feed for cattle, and if a law were to be enacted making a bushel of potatoes the equivalent of a bushel of corn in the payment of any kind of contract indebtedness, it is possible these silverites might be able to see that the farmer, above postulated, would fill any standing contract he might have made for the delivery of corn with potatoes. Thenceforward contracts for corn-delivery would mean potato-delivery. That which is intrinsically the most valuable would be kept. The corn debtor would largely gain, and the corn creditor would equally lose. The analogy of such legislation with what is proposed by the silver faction is perfect. The debtor class is to be benefited at the expense of the creditor class. The injustice of such a proposal revolts consciences not stultified by self-interest. But there are other consequences that cannot fail to be realized, should this scheme succeed.

Hon. R. B. Mahany in *The North American Review* (July) makes a strong argument upon the proposition that sound money is the safeguard of labor. Suppose that sixteen ounces of silver be made the legal equivalent of one ounce of gold, "whereas it takes thirty-one ounces of silver to purchase one ounce of gold in any market of the world, American or European; . . . who," Mr. Mahany asks, "would be the chief sufferer by such a policy?"

"Not the banker or capitalist, against whom the silver people are attempting to raise such hue and cry. The brains that understand finance and accumulate great fortunes can be depended upon to escape with a minimum of loss; but the maximum of disaster would fall upon the American laborer.

"The moment the free and unlimited coinage of silver at the ratio of sixteen to one is adopted, that moment, in all the markets of the world, our silver dollar will be rated, not at its stamped value, but at its real value of 51 or 52 cents. Sixteen ounces of silver are worth only about one-half of an ounce of gold, and hence our silver dollar at the ratio of sixteen to one will be worth only about one-half of a gold dollar. Every man who has a dollar in gold will keep it, if he can pay his debts with a silver dollar worth only half as much as the gold dollar. This will withdraw gold from circulation here; and gradually all our gold—about $659,000,000 in coin and bullion—will cross the Atlantic to pay our foreign obligations that are redeemable only in that metal.

"The withdrawal of our gold coin (aggregating $620,000,000) now in circulation would shrink our currency to the extent

of one-third. This disturbance of our financial system would be rendered the more appalling by the immediate shrinkage in the value of our silver coin to one-half of its present purchasing power. The financial stringency of 1893 would be reproduced on a gigantic scale. Depositors in banks would demand the payment of their deposits in gold. Runs on these institutions would cause fifty per cent. of them to close their doors. Notes could not be discounted, and employers doing business on a credit basis would fail. Workingmen would be thrown out of employment. Rates of interest would go up as the general ability to endure the burden declined. Crash and panic—each producing the other—would be the continuous order of the hour.

"This state of affairs would be the first calamity to fall on American labor from the free and unlimited coinage of silver at the ratio of sixteen to one. The long train of consequent and subsequent evils almost defies description."

Carrying out this argument further, it is noted that wages never rise in the proportion that value of money decreases. This was proved during the late civil war in the United States. The price of labor is also one of the last things to advance, while the prices of necessaries of life are among the first to rise during a period of depreciated currency. When an employer has the opportunity to pay in one of two kinds of money, one of which is the poorer, he follows the universal rule; he pays out the inferior money. When labor receives its pay at the end of the day, week, or month, the laborer is, to the extent of his earnings, a creditor, and the employer is his debtor. If, therefore, a money system that is to favor the debtor class at the expense of creditors be adopted, it is plain that laborers must suffer in common with the class to which they belong. Labor has now the right to demand that its wages shall be paid in as good money as anybody gets at home or abroad. Why should it relinquish its right? Bimetallism, attempted by any single country, means disaster to the country that attempts it. It is a system that can be successfully carried out only by the combined action of the nations which control the bulk of the world's commerce.

The Commercial Federation of the British Empire.

THE proceedings of the congress of the chambers of commerce held in London in the second week of June are interesting and important, not only as they relate to the future of British trade and industry, but because the measures proposed, if carried out, will ultimately influence the commerce of the entire world. Among the most noteworthy of the propositions brought before the congress was one looking to the formation of a great Britannic commercial federation, including the mother country and the colonies. The British secretary of State for the colonies delivered an address favoring the formation of such a federation on the basis of a zollverein.

The Statist (London) recently offered a prize of one thousand guineas for the best scheme of an imperial customs union. One of the competitors was Mr. J. Stephen Jeans. *The Iron and Coal Trades Review* (June 12) prints an excerpt from Mr. Jeans's scheme, as of interest in connection with the current discussion of the subject.

Having become satisfied that the ordinary bases of a commercial union—"absolute free trade between the different parts of the empire, or a system of reciprocity founded on a system of differential tariff duties"—is not immediately practicable, the author thinks success may be attained upon the basis of "reciprocal arrangements which shall involve the ultimate assimilation of the customs tariffs of the colonies to that of the mother country, on the one hand, and the adoption by the mother country of new and increased obligations towards the colonies, on the other"; and to this end he proposes "a modified system of bounties and rebates . . recognized in international relations as permissible arrangements between component parts of the same empire," and which do not have the "offensive and

hostile complexion presented to the outside world by discriminating duties."

It is thought that a common economic system founded on that of the mother country could thus be brought about, and that, if certain principles—of which a brief summary is herewith given—are observed, the colonies need lose nothing of immediate revenue, or in future industrial progress, as a consequence. These principles (which are deemed to accord with the advantage of the empire rather than with that of individual colonies) are as follows:

(*a*) Colonial representation, either in the imperial parliament, or in a national federal council instituted for the purpose of carrying out the objects of the imperial federation, on the basis of trade, as ascertained by the volume of exports and imports, — the council to be specially charged with the duty of examining the economic conditions and requirements of each dependency, and determining the "special resources, fiscal necessities, and industrial possibilities of each, and empowered to provide for the creation of customs tariffs for both local and imperial revenue."

(*b*) That the policy of imposing duties on luxuries followed in the mother country should be adopted, and, where such duties fail to yield sufficient revenue, the difference should be made up by "the rest of the affiliated possessions."

(*c*) Bounties to individual colonies for the encouragement of special industries approved by the federal council.

(*d*) Exemption throughout the empire of raw materials of industry from tariff duty.

(*e*) A gradual reduction of duties "in accordance with a differential scale, graduated in accordance to the amount of duty, until, at the end of not more than twenty years, they are entirely got rid of, looking to the ultimate adoption of a tariff for revenue only"; the federal council to be empowered to consider claims of any of the colonies that this action is prejudicial to their interests, with a view to modifying it, or making compensation for such prejudice.

(*f*) In return for colonial concessions, the imperial parliament, or the federal council, or both, to guarantee payment of interest on colonial railway investments under proper safeguards, and to assist the colonies in carrying out needful public works.

(*g*) Free carriage to the sea of agricultural products for export to the mother country, in competition with similar products from other countries, thus enabling the agricultural interests to compete with foreign producers on more favorable terms; and, further, if this does not sufficiently encourage these interests, the subsidization of vessels transporting agricultural products.

(*h*) Inquiry into and redress of any existing disadvantages which exports to colonies from the mother country sustain with relation to similar exports from other countries, such inquiry to be made by experts residing in the principal centers of colonial commerce, and required to report at frequent intervals.

(*i*) The establishment of commercial museums throughout the empire, and the creation of "special exchanges erected and maintained for reciprocal dealings in British and colonial produce only."

(*j*) Consolidation of the debts of the empire, resulting in reduction of interest upon colonial loans.

(*k*) Establishment of the currency of the empire upon a gold basis.

It is maintained by Mr. Jeans that the adoption of this scheme would result in an immediate great extension of colonial railway mileage, while, at the same time, it would not entail any rapid departure from the present system of the colonies; and railway extension is their present most imperative need. It is also maintained that an important merit of the scheme is the avoidance of "the apparently impossible condition of resumption of protection in the mother country, and the almost equally impossible condition of adopting a permanent system of discriminating duties against foreign countries." But we fail to see wherein bounties and subsidies essentially differ in principle from protective tariffs, or why subsidizing ships to carry products that

could otherwise be obtained more cheaply from other countries is not, in every essential, a discrimination against those countries. Both subsidies and bounties are radical departures from the principles of free trade, and no ingenuity in argument or plausibility of statement can make them appear otherwise to a logical mind. The countries whose competition is dreaded are not likely to be much pleased with the avoidance of the name of "discriminating duties," when a policy of discrimination as severe and rigid as that proposed shall have been put into operation. Yet it seems highly probable that in the near future measures entirely incompatible with the doctrines of free trade will be adopted by the British people.

A Unique Boycott.

IN a labor contest in Milwaukee, which began in a strike of the employees of the Milwaukee Electric Railway and Light Company early in May on the usual disagreements about wages and hours of service, the company refused to concede the demands of the men, and turned the tables by ordering a lockout of all the old force, while filling their places with new men. But, having succeeded in obtaining new men, the company is paying their wages and running the cars, without any return for the outlay, as the citizens of Milwaukee positively refuse to ride in the cars. This course, its cause, and its sequence, are described in *Iron Age* of May 28, as follows:

"Everybody except the locked-out motormen, conductors, and electricians admit that the strike is over, for the company are running their full complement of cars on schedule time. But the original issue, important at the time, has been lost sight of and swallowed up by subsequent events which have proven of far greater magnitude than the original proceedings. The peculiarity of the case is that, while the company are running their cars night and day, practically nobody rides in them, although a pretext only is made of collecting fares, and the town is said to be flooded with complimentary tickets.

"But people do not walk. They ride in 'buses run by the local union of street-railway employees, a line of these conveyances running parallel with every street-car route in town. The union started its opposition on the principal streets soon after the trouble first broke out, issuing a manifesto to the public requesting the people not to patronize street cars pending a settlement of the difficulty. A most peculiar phase of the situation is the unanimity with which the public has observed this request. It submits to delays, joltings, and all manner of inconveniences rather than turn the nimble nickels into the coffers of the much-hated car company."

It is said that this curious state of affairs is not the result of sympathy with the strikers, but of a long-standing enmity to the road caused by the operation of a law under which the company is enabled to avoid payment of its proper share of taxation. *Iron Age* says:

"A Milwaukeean's one object in life at the present time is to keep people off the street cars. A man will not only refrain from riding on the tabooed conveyances, but he carefully watches his acquaintances and puts them 'on the list,' if he catches them. In working out this unique and remarkable boycott there is no known or admitted system, and yet by a sort of natural process the thing has developed into a system which is a marvel of perfection."

Commercial Tour to South America.

THE NATIONAL ASSOCIATION OF MANUFACTURERS of the United States has planned for the summer of this year a commercial tour to South America. The circular containing the programme arrived too late for notice in our last number; but, as the tourists have been selected and invited by the committee with reference to their representative character in the industries of the United States, the details of the expedition are of less importance than its aim and the possibilities and probabilities of its success in effecting its object, which is announced as "a practical step toward the establishment of more intimate trade relations between the United States and the most important South

American nations." The party is to visit the Argentine Republic, the Republic of Uruguay, and the United States of Brazil.

The encouragement and welcome proffered from the countries to be visited are expressed in the most cordial terms in the official correspondence appended to the circular.

"The idea of this South American trip originated in the United States legation at Buenos Ayres, and was first suggested to the Argentine government. There was a prompt response, and a cordial assurance that every courtesy would be extended to such a party of representative Americans, and that every facility for observation and investigation would be placed at their disposal. The Uruguayan government, at Montevideo, and the Brazilian government, at Rio de Janeiro, were addressed in like manner through United States Ministers Stuart and Thompson, respectively, and they responded in similar terms of cordial invitation. The invitations . . . were transmitted through the department of State and for delivery to those interested, or for such use as might be deemed advisable; Secretary Olney placed them in the hands of Mr. George W. Fishback, United States secretary of legation at Buenos Ayres, now on leave of absence in the United States. Realizing the importance of this opportunity, and appreciating the far-reaching influence such a trip would exert upon the trade of the United States with Latin-American countries, the National Association of Manufacturers undertook, in acceptance of these invitations, to organize a suitable party representative of American interests, and to carry the tour to a successful conclusion."

The president of the association is Mr. Theodore C. Search. A bureau of publicity has been established at No. 1748 North Fourth street, Philadelphia, whence circulars of information are issued. These circulars are gratuitously distributed, the one announcing the tour above named being the fifth. The general purpose of the circulars is to make known the character and progress of the work of the association (which, we think, is likely to exert a profound influence upon American commerce) and to furnish valuable information to manufacturers. So far, the methods and action of this young organization indicate that it is under the direction of able and far-sighted men.

Osaka the Manchester of the Far East.

WHETHER, as some think, the Japanese are a race of imitators, or, as some fear, they will become a race of originators, the future must decide; but, if ranked as only imitators, it must be admitted that they are extremely good ones. That which they imitate is the best of its kind, and their selections of machinery, appliances, and industries from the existing stock of the civilized world exhibit a power of discrimination which proves the Japanese mind to be of a high order.

From time to time glimpses of the extraordinary progress that commerce and industry are making in Japan are given in the daily press; but so many important things are constantly occurring nearer home that few people in the western hemisphere give much attention to what is said about this progress. That it is already a factor in the commerce of the world to which older nations can not long afford to be indifferent there are many indications.

The British Trade Journal for June prints an account of the industries of Osaka, from a letter of a correspondent of the *Adelaide* (Australia) *Observer*. This correspondent, writing directly from Osaka, is so impressed with the variety and vitality of the industries of the city that he calls it "the Manchester of the Far East."

Some idea of the magnitude of the manufacturing industry of Osaka will be formed when it is known that there are scores of factories with a capital of over 50,000 yen and under, more than 30 each with a capital of over 100,000 yen,* four with more than 1,000,000 yen, and one with 2,000,000 yen. These include silk, wool, cotton, hemp, jute, spinning and weaving, carpets, matches, paper, leather, glass, bricks, cement, cutlery, furniture,

*One yen = about one American gold dollar.

umbrellas, tea, sugar, iron, copper, brass, saké, soap, brushes, combs, fancy-ware, etc. It is, in fact, a great hive of activity and enterprise, in which the imitative genius and the unflagging pertinacity of the Japanese have set themselves to equal, and, if possible, excel, the workers and artisans of the old civilized nations of the west.

There are ten cotton mills running in Osaka, the combined capital of which is about $9,000,000 in gold, all fitted up with the latest machinery, and completely lighted by electricity. They are all under Japanese management, and, it is said, all paying handsome dividends,—some as much as eighteen per cent. on the invested capital. Out of $19,000,000 worth of cotton imported into Japan in 1894, the mills of Kobé and Osaka took and worked up about seventy-nine per cent.

As Japan is not, and never can be, a sheep country, it must import the wool needed for its manufactures. America, Europe, and Australia are the sources of its wool supply. There is only one woolen mill in Osaka. It produces thick flannels with colored patterns, and employs five hundred girls and women; but an extension of woolen manufacture is contemplated, which will equal, or perhaps exceed, the cotton industry in importance. A large increase of demand for Australian wool is, therefore, expected. The manufacture of wool carpets is about to be commenced. Cotton and jute carpets and rugs are already made in Osaka in large quantities. Osaka also contains the mint which coins the money of the empire.

One of the most notable characteristics of the Japanese is intensity of application. Be he student, merchant, artisan, or worker, it is all the same; work is deemed the natural condition, not a hardship of life. No idle class and no industrial strife as yet exist in Japan.

The British Commercial Congress.

THE significance of the proceedings of the congress of chambers of commerce of the British empire, held in London in the second week of June, is apparent to all careful observers of current events. Rising far above all other topics in importance, the feasibility of forming a grand commercial federation which will include all the British possessions was the subject most thoroughly considered and most earnestly debated. The colonial secretary, Mr. Chamberlain, in speaking to this question, declared that there were only three lines upon which, in the nature of things, such a federation could be brought about, or upon which suggestions of a scheme for it could be framed. The proposal that the colonies should abandon their present fiscal systems for a system of free trade is one of these lines. The abandonment of free trade by the mother country in favor of the colonial systems is another. The creation of a British zollverein, as proposed by the Toronto board of trade, is a third, and this the secretary thought the only line upon which any progress could be made.

The features of the Toronto scheme are the establishment of practical free trade throughout the empire, without restrictions upon the contracting parties affecting their arrangements with regard to foreign goods, with the single exception that moderate duties on articles of large production in the colonies shall be imposed by the imperial government. Without going into details, Mr. Chamberlain expressed the view that the Toronto scheme had in it the germs of a successful federation, and he thought that a proposal coming from the colonies to enter into such a federation would not be refused. However, no definite conclusion was reached, beyond the passage of a resolution expressing the opinion that prompt and careful consideration of the establishment of closer commercial relations between the United Kingdom and its colonies should be given by the home government.

The debate and the action taken indicate in the plainest manner that the idea of such a federation has taken a strong hold upon the English mind, and it is not likely to be dropped. Should a scheme of this kind be carried out, it would have a profound effect not only upon English and colonial commerce, but upon the commerce of the entire civilized world.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*6503. The Cause and Remedy for Business Depression. Edward Atkinson (Showing that hard times result from tampering with the standard of value, and that the way out is to restore the credit of the monetary unit). Eng Mag–July. 4500 w.

*6509. Japan's Invasion of the Commercial World. Allen Ripley Foote (Showing that the inferiority of imitation to invention, as well as other causes, must disable the oriental nations for serious competition with the United States). Eng Mag–July. 3700 w.

6637. The Influence of Manufactures on Wealth and Popular Intelligence (Extract from an address of Governor Lippett, of Rhode Island, showing the importance of manufactures to a community). Mfrs Rec–June 19. 1500 w.

6638. What Is Most Needed to Bring About Greater Prosperity for the General Industrial Interests of the Entire Country? (Replies to the question from Courtenay De Kalb, and L. Warfield). Mfrs Rec–June 19. 3800 w.

*6704. The Commercial Federation of the British Empire. J. Stephen Jeans (The lines upon which such a federation ought to be formed are indicated in nineteen distinct propositions which are ably supported in an elaborate argument). Ir & Coal Trds Rev–June 12. 3500 w.

6730.—$1. Some Observations on Railroad Pooling, and the Conditions upon which Pooling Contracts Should Be Authorized by Law. M. A. Knapp (The author sets forth reasons for the belief that the interests of the public would be promoted by allowing rival railroads to substitute,—under certain restrictions,—coöperative for competitive methods). An Am Acad–July. 6500 w.

*6734. The Import Trade of Japan (The trade is said to be confined to the supply of government requirements and of railway, shipping and joint stock companies with materials. Methods pursued and peculiarities of each of these classes of import trade are briefly described). Bd of Tr Jour–June. 2000 w.

*6735. The Industries of Osaka and Competition with Australian Products. (This town is described as the "Manchester of the Far East," the largest and most important commercial city in Japan. Its commercial resources and relations are interesting topics). Bd of Tr Jour–June. 1900 w.

*6736 Commercial Treaty between Germany and Japan. (Full details of the treaty with list of articles and *ad valorem* rates of duty comprised in the treaty). Bd of Tr Jour–June. 1400 w.

*6737. New Customs Tariff of Mauritius. (Complete list of articles with rates of duties now levied). Bd of Tr Jour–June. 1500 w.

*6738. Tariff Changes and Customs Regulations. (Russia; Sweden; Germany; Belgium; Spain; Roumania; Turkey; Egypt; United States; Nicaragua; United States of Colombia; British India, and Jamaica). Bd of Tr Jour–June. 7000 w.

†6812. Sound Money the Safeguard of Labor. Rowland B. Mahany. (An argument against the proposition that "gold is the money of the bankers and silver is the money of the people"). N Am Rev–July. 1100 w.

†6813. The Necessity of Limiting Railway Competition H. T. Newcomb. (While credit is given to the interstate commerce law for much good during the nine years it has been in force, it is thought that the effect of preventing railroads from mitigating by agreement the force of competition for traffic, was unanticipated and is undesirable. An argument for legislation to remove this disability, follows). N Am Rev–July. 1800 w.

†6832 Sociology in Ethical Education. Byron C. Mathews (Our schools are considered as responsible in a considerable degree, for existing social discontent through their lack of ethical instruction, and the want of attention to the inculcation of sound principles of social relations). Pop Sci M–July. 3500 w.

6834. The Apprenticeship System under Modern Conditions (System employed in shops of the Brown and Sharpe Company). Sci Am–July 4. 800 w.

*6858. French Labor Question. H. K. Landis (Description of labor system in the works of the Société J. & A. Pavin de Lafarge). Gunton's Mag–July. 2500 w.

*6859. State Ownership of Railroads. Frank L. McVey (Such an investment is shown to involve an investment three times greater than the cost of our late civil war; that the principle involved embraces equally government ownership of mines, factories, and other large industries; that the burden of all losses would fall upon the public; that the interest on the investment at 6%, would be at least $600,000,000, that it would add 800,000 to the number of government employés, and that it is an utterly impracticable scheme). Gunton's Mag–July. 3600 w.

6892. The Municipal Ownership of Gas and Electric Plants. T. B. Fersse (An argument favoring municipal ownership). Pro Age–July 1. 7000 w.

6894. Municipal Advantages.—How to Obtain Them Allen R. Foote (An argument against municipal ownership). Pro Age–July 1. 7500 w.

†6919. A Unique Strike and Boycott, with Its Results and Lessons. C. B. Fairchild (Full account, from its initiation to its close, of the strike of the employés of the Milwaukee Electric Railway and Light Company, and the boycott that followed). St Ry Jour–July. 3500 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

The German Navy.

THE summer meeting of the thirty-seventh session of the Institution of Naval Architects, held in June, was an occasion for the presentation of many able papers, among which were two that any intelligent layman may read with interest and pleasure. No previous knowledge of the technicalities of naval architecture or of marine construction, beyond such as may be assumed for any fairly-educated man, will be needed in their perusal. The paper, "Development in Design and Construction of German Men of War," by Herr A. Dietrich, constructor-in-chief of the imperial German navy, and another, "Shipbuilding in Germany," by Mr. C. Ferd. Laeiz, the first dealing with the military, and the second with the merchant marine of the German empire, are the papers referred to.

The first-named of these papers contains the frank acknowledgment that England has been the instructor of Germany in the art of shipbuilding,—hulls, engines, and boilers. The first German ironclad, the turret ship Grosser Kurfürst, was begun in 1869 at the yet unfinished Wilhelmshaven dockyard. Recounting the progress made since that period, with mention of ships which have been built, the author said:

"A special feature in the German navy has always been the 'avisos,' speedy vessels of small fighting capacity, designed only to serve as scouts for the fleet. But soon these vessels were required to fight, especially after the introduction of the torpedo; in consequence, the vital parts had to be protected. Out of the last German vessel of any size built abroad, by the Thames Ironworks, 1875–76,—*viz.*, the Zieten,—the modern German 'avisos' were developed. These were, first of all, the Blitz and Pfeil, with under-water torpedo armament and of 16 knots' speed, forerunners of the later-built English boats, Surprise and Alacrity. The Greif, of 19 knots' speed, succeeded in 1885, and was followed by the Wacht and Jagd, of 19½ knots' speed, and fitted with a protective deck. After these come two small 'avisos' of the same speed, the Meteor and Comet, of 1,000 tons, and then the 'avisos' Hohenzollern, a splendid vessel fitted out as an imperial yacht, with 21.5 knots' speed, of about 4,000 tons displacement. The last of the 'avisos' is the Hela, of 2,000 tons displacement, now beginning her trials."

The torpedo division boats and torpedo boats are passed by the author with a mere mention as part of the German naval outfit. A table of data pertaining to five German warships now in course of construction is presented, but a clear statement of differences between German and English warships is of more general interest.

"The armor-clads, armored cruisers, and protected cruisers are divided into as many water-tight compartments as was deemed possible without interfering with the working of the vessel. Perhaps this is carried out already too far, and the service on board may be obstructed. The paper of Lord Charles Beresford, read before the meeting of the Institution in March of this year, mentions those considerations which prompted the constructor here to carry every athwartship bulkhead above the water-line, without any door in it. Any door may be left open; therefore one has to accept the probability that it will be left open; and, consequently, it is better to have no door at all. Communication from one engine-room to the other, from one stokehold to the other, must be established only over the protective deck, above water, or may be carried on below by telegraphs and speaking-tubes. Only in the athwartship bulkheads, which are beneath the protective under-water deck of citadel ships, or in the foremost and aftermost parts of protected cruisers, doors are permitted. This

circumstance speaks strongly against the construction of such vessels. The above-mentioned principle is strictly adhered to in all new German navy vessels. It is difficult to ventilate a ship divided in this way. Air from above must directly lead into, and out of, each compartment between two athwartship bulkheads, which has direct access from above. Only for the forward and aft compartments underneath the protective under-water decks air-ducts are carried through the athwartship bulkheads, and water-tight shutters have to be provided for, which are perhaps insufficient, but have to be made use of in vessels of the citadel type.

"Modern vessels suffer a great deal from the heat which radiates from the steam piping belonging to the large number of auxiliary engines installed in all parts of the ship, and which supplies the ship with continuous steam heating. All attempts of engineers to cover these pipes with non-conducting materials, and to insulate them so as to prevent their radiating heat, have entirely failed, and every room through which a steam pipe is carried is heated very disagreeably. The best method of counteracting these effects of steam engines and steam pipes was found to be by omitting them, and by employing electricity, the conducting wire taking the place of the steam pipe. Only by driving the many fans made necessary for the water-tight compartments by electricity is the division into so many compartments rendered at all possible. All new German warships in course of construction have electricity as motive power, not only for those ventilating fans, but also for the turning gear of gun-turrets, for ammunition hoists, for boat-hoisting, and coaling winches, and such like gear. For the turning gear and ammunition lifts of the heavy guns, hydraulic power has been retained, and steam is still used for the steering gear where it was especially difficult to install the electric motor, as well as for the anchor windlasses, which are only comparatively seldom used. Only one vessel in the German navy, the nearly finished Aegir, is experimentally fitted throughout with electric appliances, even for steering gear and windlasses. The results of these experimental installations will decide if, in the future, electricity can be used more extensively for motive power on board ships, and if the heat sources can be further dispensed with."

Among other differences named is the division of motive power. More auxiliary machinery is used, requiring a greater number of attendants. Steel-plate decks, some covered with linoleum and others with cork, have replaced wooden decks. Restricted use of wood in the construction of hulls has been practised for the purpose of lightening hulls. Interesting innovations in furniture, involving the use of steel and aluminum, have been abandoned, such furniture having been found less satisfactory than wood furniture. The beds, however, are of iron, steel, or brass.

The question as to the rival claims of water-tube boilers remains unsettled, and is regarded as one which can be settled only by experience. But the author quotes with approval the proposition laid down by a writer in the (London) *Daily News*: "In the next war the side which has the best boilers will win."

The Future of Nantes as a Port.

A RECENT report of the United States consul at Nantes, France, speaks of the increased marine traffic at that port, and thinks this is to become one of the principal French ports. The maritime canal of the lower Loire is the cause of this impulse, which has taken place in spite of the general depression in French commerce. We have condensed from the report the following particulars relating to the canal, which takes the place for heavy navigation of that section of the river comprised between the extremity of the dykes —*à la Martiniere*—and Paimbœuf, in which are the highest banks and the most difficult channels to keep open. Work was commenced on the canal in 1882, and on September 1, 1892, it was delivered over to navigation, and completed the following year.

The canal proper is 9 miles 635 yards in length, and is closed at each end by locks 328 feet long, 122 feet wide, and with an

entrance of 59 feet width. Close to each of these locks there is a basin 1,148 feet 4 inches long by 492 feet 1½ inches wide, which permits the waiting and passing of vessels.

The width at water level is 180 feet, and at the bottom or floor 90 feet. At points one-third of the distance from each end there are docks for the passage of meeting vessels. On each side of the canal there is a towpath of broken and roller-pressed stone, and also numerous stocks for embarking or disembarking agricultural produce or animals. The draught of vessels passing through the canal is constantly increasing, and, although in its normal state the canal is supposed to furnish largely 19 feet 8¼ inches of depth, a vessel drawing 21 feet 1¾ inches has successfully passed, and with the aid of water drawn from the feeder—*l'achenean*—the level can be raised so as to permit during full tide the passage of a vessel drawing 24 feet 6 inches.

The number and tonnage of vessels passing through the canal have constantly increased from its opening to the present time. In 1892—four months—the figures were 123 vessels and 39,000 tons; in 1893, 595 vessels and 206,313 tons; in 1895, 791 vessels and 334,500 tons. The average tonnage has risen from 325 tons in 1892 to 423 tons in 1895.

The channel between Le Pellerin and Nantes is less satisfactory, although it has been improved by dredging, having been deepened nearly four feet since 1893.

It was easier than at first anticipated to obtain a depth of 18 feet at low tide and still water, but it has been more difficult to maintain this result at all times of the year and under all circumstances. The means at disposal of the engineers have proved insufficient to remove promptly the sand bars formed by floods or ice, an example being the closing of the river for navigation through ice for nearly a fortnight in February, 1895. After the breaking up of the ice the channel was inaccessible to vessels drawing more than 16 feet of water, for several days, owing to defective dredging. This proved a salutary lesson, as the chamber of commerce of Nantes, in conjunction with the ministry of public works, took steps to procure at once the appliances necessary to keep the channel always open with a 20 feet draught of water.

Skilled and Unskilled Marine Labor.

IN the *Yale Scientific Monthly* (June) Mr. Henry S. Pickands draws attention to the fact that on sea as well as on land the effect of mechanical improvement upon the status of labor is making itself felt. Ships now use many machines and mechanical appliances unknown to a past generation. A certain degree of skill, required for the use of these improvements, has differentiated crews into skilled and unskilled men, which differentiation has already differentiated the wages of the two classes thus evolved, and will still further differentiate them. The unskilled do and will include men who require little intelligence, but great physical endurance,—coal-passers, deck-hands, etc. The other class does and will include men of some education, judgment matured by experience, and mechanical training, ranging from the first-grade engineer down to the oiler. Marine machinery now comprises, in many cases, electric lighting, refrigerating, and ice-making machinery, etc., so that the upper grade of the engineering staff must now include men of much wider knowledge and greater mechanical skill than was necessary twenty years ago for the competent supervision of the propelling engines, pumps, and hoisting machinery,—to say nothing of the increased skill and knowledge needed to run a modern triple- or quadruple expansion engine, as compared with the marine engines of the last generation. While this change in the character of the men has been slowly evolving, a fully corresponding change in the status of the skilled part of the crew has not yet been made. The skilled engineer is yet too much under the domination of officers unskilled in engineering, and is too often compelled to do what his better judgment condemns. This state of things can hardly be avoided, until the superior officers of the ship shall be selected from the grade of chief engi-

neer, making the line of promotion continuous from bottom to top. If this ever comes to be, the superior officers will themselves be past engineers of a high order of skill, taking the responsibility that should always accompany authority, and which should not be imposed without authority; and the engineer's duties on board ship will be relieved of many needless cares and embarrassments.

Explosions of Water-Tube Boilers.

THE fact that explosions in this class of boilers are more frequent than they were formerly indicates that in some of them a departure from sound mechanical principles has been made. It is not a sufficient answer that, as higher steam pressures are used, the liability to explosions has increased. This might account for leaks, or the rupture of single tubes; but the fact is that in this type of boilers some of the accidents that have occurred have been so general in their effects upon the boilers themselves and in their destruction of adjacent life and property that they are, and ought to be, called explosions.

The Practical Engineer (June 26) describes such an explosion on board the French ironclad "Jaureguiberry," one of the finest and latest additions to the French navy.

"The steam on this vessel is furnished by twenty-four water-tube boilers of the Lagrafel-D'Allest type. The vessel had gone for a twenty-four hours' trial trip off Toulon on June 9. Up to the twentieth hour everything went on satisfactorily, and then, without any warning, an explosion occurred in one of the boilers, which blew open the furnace doors and sent a rush of steam and flame into one of the stokeholds, so severely scalding nine stokers who were in it at the time that six died within a few hours.

"After the disaster it was found that one of the tubes had drawn from the front tube plate and burst, in addition to which a large number of the other tubes were drawn and bent. Why the tubes should have failed in this way is not satisfactorily explained. The fact, however, that one of these water-tube boilers should have given out the first day on raising steam, with such disastrous results, reveals uncomfortable possibilities to those who have so strongly advocated water-tube boilers for use in the British navy."

This will prove a damaging blow to the commercial exploitation of the type of boiler named, which rival interests will not fail to make the most of.

It is worth while to enquire whether the safety that has been claimed for water-tube boilers has not depended much upon the conditions of their use prior to their adoption for marine purposes.

As stationary boilers on land, they are usually provided with ample space, with egress for attendants on the same level, in wide contrast to the limited room that can be allowed for them on board ship. The escape of attendants is thus rendered more easy and probable, should a local rupture occur, than it ever can be on board ship, where escape from a stokehold usually means the climbing of stairways or ladders.

But the condition of the boiler above referred to shows that there was a more extensive wreck than the mere rupture of a single tube permitting a gradual efflux of steam.

The precise cause for the occurrence has not been explained; but it is evident that, if the boiler is of a character that permits the rupture of one tube to do all the mischief stated, its construction involves wrong principles, and it is an unsafe steam generator for marine service. Instead of independence, there must be some sort of mutual interdependence of the tubes that renders the rupture of one of them the cause for the effects produced upon the others. The anxiety to make the weight of water-tube boilers a minimum, and to increase the rapidity of their action when fired, has, we believe, led to ignoring points essential to safety and durability, not in this particular construction alone, but in other water-tube boilers that have claimed to be superior to fire-tube boilers for use on ships.

This sort of thing is as liable to occur on a warship in action as at any other time, and it might well determine the

issue of a naval encounter. Clearly, we are not at the end of developments in the attempt to substitute this new system for the old one, which, though not free from faults, has a record for reliability in service that water-tube boilers, as a class, will be long in acquiring.

UNDETERRED, apparently, by the movement in Congress to have steam yachts which are built outside the States debarred from flying the Stars and Stripes, and from sharing in the privileges and exemptions which that distinction confers, Mr. Robert Goelet, of New York, brother of Mr. Ogden Goelet, for whom a similar yacht is at present well under way in the yard of Messrs. J. and G. Thomson, Clydebank, says *The Engineer* (London), has just commissioned that firm to build him a twin-screw steam yacht of 1750 tons yacht measurement. Like his brother's vessel, the later boat will be most sumptuously fitted, and will be propelled by triple-expansion engines, capable of giving a speed of 18 knots.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*6553. The Design of Warships (Editorial review of correspondence upon this subject chiefly that which has appeared in its columns with the signature "Argus"). Engng–June 5. 3800 w.

*6599. Auxiliary Naval Machinery. Henry S. Pickands (Illustrated description of a steering device, and of a search light, with general discussion of the effect upon crews, resulting from use of auxiliary marine machinery). Yale Sci M–June. 1800 w.

6679. Breakdown of the "Merida's" Engines (Illustrated description of one of the most complete wreckages of a marine engine on record). Eng–June 20. 1000 w.

*6695. Our New Cruisers (Illustrated description of the new English cruisers "Niobe," "Doris" and "Powerful"). Engng–June 12. Serial. 1st part. 3300 w.

*6699. Development in Design and Construction of German Men-of-War. A. Deitrich (Read at meeting of Inst. of Naval Architects. The history of the present German navy and the difficulty of producing vessels rivalling those of England and France in German dock-yards and with German materials, are narrated in this paper. It is illustrated by diagrams showing the lines of three important German ships). Eng, Lond–June 12. 4000 w.

*6700. Thames Paddle Steamer Southend Belle (Illustrated general description). Eng, Lond–June 12. 1500 w.

*6701. Shipbuilding in Germany. C. Ferd. Laeisz (Read at meeting of the Inst. of Naval Architects. Brief survey of the development of the industry). Eng, Lond–June 12. 2100 w.

*6703. The Maritime Position and the Principal Features of the Port of Hamburg. Franz Andreas Meyer (Read at the meeting of Inst. of Naval Architects An eloquent and interesting description of this important port). Eng, Lond–June 12. 4000 w.

6751. The New Double-Deck-Turret Battleship Kearsarge (Illustrated description). Sci Am–June 27. 1300 w.

6753. Four-Masted Steel Schooner Honolulu (Illustrated description). Am Ship–June 25. 800 w.

*6778. Recent Improvements in Docks and Docking Appliances (Preliminary remarks upon the ideal requirements of docks and docking appliances. A statement of how far they have hitherto been met and an illustrated description of the new dock for the port of Barrow-in-Furness, claimed, in its design, to be a decided advance over other docks). Eng, Lond–June 19. Serial. 1st part. 2800 w.

*6784. The New Docks at Portsmouth (Interesting description of the harbor of Portsmouth, Eng., and of the two large new docks rapidly approaching completion, and which will accommodate the largest English warships). Trans–June 19. 4200 w.

6833. Oil Engine Signaling Plant on United States Lightship No. 42 (Illustrated detailed description) Sci Am–July 4. 1600 w.

*6934. Marine Boilers, Particularly in Reference to Efficiency of Combustion and Higher Steam Pressures. (Abstract of a paper read before the North-east Coast Inst. of Engineers and Shipbuilders. Steam pressure of 250 to 280 lbs. being deemed probable in the near future, the author proceeds to discuss the points in boiler construction requiring attention, besides mere ability to withstand these pressures when adopted. Ind & Ir–June 26. 2400 w.

*6940. On Signs of Weakness in Tank Steamers. Otto Schlick (Read at meeting of Inst. of Naval Architects. An attempt to account for the symptoms of weakness in tank steamers in strakes of outside plating, and suggestions for remedying the difficulty). Eng, Lond–June 26. 1000 w.

6948. Minimizing the Effects of Collision at Sea (Extract from address delivered at General Chamber of Commerce, Hong Kong, by Rear Admiral S. Makaroff, Imperial Russian Navy. Deals with appliances for protective use, and with methods of construction designed to lessen risk of damage through collisions at sea). Eng–July 4. 1800 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Boiler-Tube and Boiler-Setting Practice.

ALWAYS holding in high esteem the system of topical discussion now so much in vogue in engineering associations, we find that our estimate of the value of this mode of bringing out ideas, opinions, and experiences has been, if possible, heightened by the perusal of the Proceedings of the American Boiler Makers' Association for 1895, a large part of which is given to a report of such a discussion upon boiler-construction and boiler-setting. It might be imagined that a free talk among members upon so trite topics could not be otherwise than dull, but such an opinion would be far from the truth. On the contrary, it was animated and interesting, and it brought out in clear light many features of present practice in boiler-construction. The first question discussed was: "Is there any advantage to be gained by beading over the ends of boiler-tubes in comparison with properly expanding them with a roller-expander?"

Mr. Farmer (chief engineer, United States navy) said that he preferred not to bead over tubes, because, if they are not beaded, they have some elasticity and life left, and can be expanded again. If a roller-expander is used in the first instance, a Prosser expander can be used when the tubes get very bad, and he believes that they hold just as well when properly rolled as when beaded. The general sense of the members present was adverse to beading, but there was some difference of opinion as to the distance that tubes should protrude. Most who took part in the discussion agreed that the part which protrudes, whether long or short, ought to be somewhat expanded.

Mr. O'Brien, in favoring this opinion, said that his reason for not bending them down was that, when a piece of iron or steel is flanged flat, the part turned in, as a general thing, is cut or broken more than half-way through.

Mr. H. S. Russell said that he had been setting tubes without beading for thirty years, with the expander coming beyond the head, so as to give a little flare to the tubes. But he had met a difficulty. If the tubes project more than one-eighth of an inch through the back head, they burn, and become brittle. If, therefore, the tubes are passed through the back head more than one-eighth of an inch, he thought they ought to be beaded; but not for strength. He had never known a tube to slip for want of beading, but he had known tubes that were not beaded to burn, so as to be practically destroyed, becoming so brittle that they would break clear into the head; in such cases they must be taken out.

Another member thought it better not to let the tubes protrude so much as one-eighth of an inch. On the contrary, Mr. Garstang advocated the protrusion of the tubes to from one-fourth to three-eighths of an inch. He had never met the trouble specified by Mr. Russell, but he did not approve beading. This last was the sense of twelve out of fifteen of those who spoke to the question.

A second question was then discussed: "Do you think there is any advantage in having one or more vertical spaces between tubes to assist circulation, in comparison with ample space between each two vertical rows of tubes?"

Upon this question the discussion was lively, bringing out such a diversity of opinion and practice that the merits of the question do not appear to have been decided in favor of one practice more than the other. In either case, if too many tubes are not put in a boiler, the circulation will be satisfactory, and removal of scale will not be difficult.

The punching of rivet-holes to a smaller diameter than needed, and the enlarging of the holes with a drill to the proper size, were strongly advocated by a majority.

There was general agreement that the depth of a flange for boiler-heads should

be about six times the thickness of the plate.

There was a good deal of difference of opinion upon the subject of bridge-walls. It was generally conceded that bridge-walls are needed for the best consumption of fuel, but there was a wide divergence of opinion as to the shape of the bridge-wall and its distance from the boiler shell. On the whole, the straight bridge-wall appeared to be most favored, and Mr. Allen, of the Hartford Boiler Inspection and Insurance Company, gave as a scientific reason for this preference that a round-about bridge-wall intercepts radiant heat from the grate.

Structural Stiffness and Mechanical Flight.

THE problem of mechanical flight still commands the attention of able men. One of these, Mr. Maxim, has won fame and wealth by his achievements, and is deservedly ranked among the foremost inventors of the age. His experiments in mechanical flight have been carried out on a scale without a precedent. They show that mechanical flight is possible. The experiments of Professor Langley show the same thing. Herr Lillienthal has also succeeded in making short flights. We may admit, therefore, that the possibility of flying through the air by self-supporting mechanism is now a demonstrated fact.

What then? Is mechanical flight, for anything except some limited special service, a practicable scheme? In novels and illustrated papers the wild imagination of dreamers have been presented to the general public mind, and many have come to believe in the probability that gigantic air-ships will, at some not far distant time, carry passengers across the seas, meet in conflict in the clouds, and carry on a commerce between nations, as marine vessels now do. The mechanical engineer, however, sees the enormous gaps that lie between these imaginings and the possibilities of achievement, as they now exist; and he needs only to consider the materials available for mechanical construction to beget in him the profound conviction that the idea of transportation of passengers or freight on a commercial scale by flying-machines is entirely chimerical.

An editorial on this subject in *The Practical Engineer* (June 26) speaks of a letter recently written by Mr. Maxim to the *Times* (London), in which this eminent mechanical engineer intimates very clearly that the weight of materials as related to strength is an obstacle yet unsurmounted in the attempt to construct a flying-machine of large lifting and sustaining power.

"In the case of the small experimental apparatus which Maxim used prior to the construction of the large machine referred to, he found it possible to exert an upward lift equal to fourteen times the thrust of the driving screw,—that is to say, that, when the screw exerted a thrust of 3 pounds, he could lift $14 \times 3 = 42$ pounds. In constructing the large machine, however, 'it was,' he says, 'necessary to stay it in every direction,' in order to obtain the stiffness requisite for stability. The result of this was not only to add proportionately much greater weight, but at the same time to materially increase the frictional resistance. The consequence was that, when the machine was tried, the lifting effort, instead of being fourteen times, as in the small machine, was only five times the thrust of the screw. In other words, its efficiency for flotation was reduced to one-third, and this notwithstanding that the engines were worked to double the capacity they were originally designed for; so that, as Mr. Maxim states, 'the factor of safety was very low.'"

Commenting upon the statement of Professor Langley (approved by Mr. Maxim) that the difference in efficiency between large and small machines (resulting from the greater relative weight of structures as they increase in size) "is an unknown factor as relates to size, unfavorable to large machines," the editorial under review says: "This factor, however, is not so mysterious or unknown as Mr. Maxim and Professor Langley would appear to think. It is a recognized element in engineering design, whether relating to flying-machines, bridge roofs, or any other framed

structures, and it is this recognition of the inexorable limits imposed on the size of structures by the nature of the materials available that has enabled engineers to realize the enormous difficulties that lie in the way of man's attempt to exercise that dominion over the air that he does on land.

"In the case of all motors, whether animate or inanimate, the weight increases much more rapidly than the increase of power, simply from the fact that the dimensions of the beams, cantilevers, and links of which they are, structurally speaking, composed, require to be increased at a much greater rate than the span or leverage, as the case may be. Take the case of a simple rectangular beam: as far as strength is concerned, this may be said to vary inversely as the length, but structures cannot be designed with this view alone, at least not when rigidity and permanence of form are essential factors. Other things being equal, if the length be doubled, the deflection would vary as the cube of the length; in other words, a beam of the same section with a double span, although it would be twice the weight, would have eight times the deflection. To secure the same stiffness it is almost invariably necessary to employ a much greater quantity—and therefore weight—of material than the increase of span would indicate to those unfamiliar with the laws which govern stiffness, and it is this consideration which, even with the strongest materials available, soon imposes limits on the size of bridges, roofs, etc."

The structure may be so large (for instance, the Forth bridge) that the load it is intended to support over and above its own weight is almost nothing in comparison with that weight. The mechanical structure of living beings—*e. g.*, birds—conforms to this law of limitation as surely as artificial structures. The larger birds, whose fossil remains may be seen in geological museums, did not fly. The largest known living bird, the ostrich, does not fly. His wings only assist his feet; and yet the largest birds have always been small in comparison with other contemporaneous land and marine animals. Moreover, birds of flight can stop and, so to speak, "coal up" at will. The stock of fuel which a wild duck needs for temporary use he can obtain by settling down upon any convenient stubble field. So far as known, the absence of stubble-fields in mid-sea has hitherto prevented birds whose natural habitat is the land from attempting flight across large bodies of water. So that, while we may admit mechanical flight to be a demonstrated possibility, its future general commercial practicability may well be doubted by those who do not rest opinion upon the vain imaginings of writers of fiction.

Powdered Coal as Fuel.

WE have not met a better article on the subject of powdered coal for fuel, as developed in Germany, than that read by Mr. Bryan Donkin before the Federated Institution of Mining Engineers at its recent meeting, and reported in *The Colliery Guardian* (June 12).

In the course of the essay the author says that weight is not the proper standard for the purchase of coal, and that the price paid for fuel should correspond to "the quantity of heat it contains." This proposition is not expressed very scientifically. The quantity of heat developed in its combustion is evidently what the author means. But, as this can not be determined for coal or any other fuel, except by an experiment for each sample, supposed or proved to be a fair sample of the coal purchased, and as the amount of heat developed must depend upon more or less complete combustion, the suggestion seems to be impracticable in the coal trade. It is also suggested that a sliding scale should be adopted for the amount of dirt contained in coal, which varies in different samples from five to fifteen per cent. of the entire weight. This dirt produces useless and harmful clinker, which costs time and labor to remove. But, when Mr. Donkin says "it is not tons of coal, but so much heat," that boiler-owners want when they buy coal, he puts an old truth into new and forcible expression.

Powdered coal, in combining with oxygen in the act of combustion, will generate

more heat than can be obtained from it in any other way, except by first converting the coal into gas, and the pulverization of coal at the cost of one shilling per ton (alleged to be the average cost) is considerably less than that of making a ton of coal gas. The reason why more heat may be obtained from powdered than from lump coal is that, with suitable appliances, a more perfect and rapid combustion can be effected. Twenty years ago or more the extensive experiments of the American engineers, Whelpley and Storer, proved this to be the case. But these experimenters were ahead of the times, and they failed to make a practical commercial success of the system.

At the present time five systems of burning powdered coal are working in Germany. The forced blast is used with some, as it was used by Whelpley and Storer. Others employ a natural draft only, with means for continuously supplying the powdered coal to the furnace for maintaining continuous combustion. Of the latter class is the Wegener system, which sifts the powder into a current of air entering by natural draft, quite uniformly, the sieve through which the fuel passes being aided in its delivery by a tapper which beats against the sieve to which the coal is supplied. This tapper is operated by an air turbine working in the duct which supplies the air, the air current being set up by heated gases passing out through a chimney stack in the ordinary way. The arrangement could scarcely be more simple. The powdered coal falls into the ascending current of air, and, thus thoroughly mixed with the supporter of combustion, passes with it into the furnace, becoming almost instantly ignited and burning with intense heat.

The sieve employed is of wire gauze, sixty meshes to the inch,—and the particles of coal are reduced, before use as fuel, to a fineness of from $\frac{1}{100}$ to $\frac{1}{1000}$ inch.

In the discussion elicited by the paper, some thought the fineness of the coal had been carried further than necessary. This was the opinion of a member who said he had been experimenting with powdered fuel; but, on general theoretical principles, the finer the dust, the more instantaneous and complete should be the combustion, so that the fineness of the coal becomes purely a question related to cost of producing the grade of fineness used, as considered with reference to the effect gained by a superior grade of fineness.

A question which might have been raised, but which does not appear either in Mr. Donkin's paper or in the discussion, is the proper method of disposing of the ashes remaining after the combustion. The dirt fuses into slag under the high temperature produced; but, in a current of air strong enough to carry along coal particles of $\frac{1}{100}$ inch fineness,—the particles of the ashes resulting being much smaller and lighter,—we should expect, without some special means of separating them from the spent gases, that they would all be carried up and out of the chimney, thus substituting a new nuisance for the old smoke nuisance, the abatement of which Mr. Donkin claims as a point much favoring the use of powdered coal as a fuel for steam generation.

Preventing Sponginess in Castings.

A GERMAN patent recently issued to Mr. Fr. Krupp so well sets forth the cause of non-homogeneous castings and the reasons for frequent failures of aluminum as a preventive that we condense from a ranslation in the *American Manufacturer* (June 12) the following clear explanation of the reactions which take place in molten metals when aluminum is added. The object of the process is to free steel, nickel steel, and other alloys, which, by reason of the manner of their production, contain oxygen, from this oxygen during casting. If not prevented, the oxygen will combine with the carbon that is always present in the casting material, forming carbon monoxid, and, as this union takes place rather slowly, there is always danger of blow-holes being caused. Until now it has been the custom to prevent this evil by adding to the liquid material during casting aluminum either pure or in combination with iron or steel, with the result that the oxygen, which chemically is more closely related to aluminum than to carbon

and iron or the other metals contained in the casting material, was absorbed by aluminum by forming with it fine clay earth, which to a large proportion remained suspended in the casting.

Although the formation of blisters was prevented by this means, the clay particles still represented an impurity in the castings. Now, this impurity, too, can be removed by adding to the liquid material, instead of aluminum or its iron alloy, an alloy consisting of one or more metals of closer chemical relation to oxygen than that possessed by the metals to be cast, and one or more electro-negative, non-metallic elements or metalloids, like silicon or boron. The elements of such an alloy, if mixed in proper proportion, are transformed by absorption of oxygen into silicates, borates, etc., which produce a more or less easily fluent slag. The latter, being formed very quickly, rises in single drops to the surface of the liquid and considerably heavier casting material, and makes it perfectly pure and free from blisters.

Best suited for metallic addition will be aluminum or alkaline earth metals, like magnesium, either each metal by itself, or two or more combined, or in combination with one or more other metals, like manganese or iron, while the non-metallic flux should consist of silicon. As the single silicates do not produce as easily fluent slag as the double or multiple silicates, the use of at least two metals for flux will be advisable.

The use of alkaline metals, like potassium, sodium, etc., can hardly be thought of, although they possess the greatest chemical relation to oxygen, or rather for this reason,—because their quick and violent combination with oxygen may lead easily to explosive occurrences. Besides, their higher price is an obstacle to their adoption. Pits non-metallic addition boron is in many cases just as good and sometimes even better than silicon, because borates will volatilize at lower temperatures and evaporate out of the liquid casting as soon as formed to boracic acid gas by their combination with oxygen.

Silicon or boron may be replaced by phosphorus or a similar element, for the purpose of the non-metallic flux is solely to form, by the absorption of oxygen together with the metallic flux, easily fusible or volatile combinations, and to prevent the formation of powdery secretions.

An especially suitable addition for steel casts is an alloy of aluminum with manganese and silicon, the two latter substances in the form of ferro-manganese and ferro-silicon in the proportion of five per cent. of aluminum to ten per cent. of manganese and ten per cent. of silicon for seventy-five per cent. of iron. Even if manganese should be left out of this mixture, it is probable that a bi silicate, silicate of aluminum and iron, would be produced, but the presence of manganese will furnish a surer guarantee for the formation of an easily fluent slag.

Care of Engine Cylinders and Pistons.

IN an article on this subject, Mr. E. H. Kearney in *The Safety Valve* (June) says truly that one of the most common defects is a leaky piston caused by imperfect piston packing. The attention of engine-builders has been directed earnestly to the supply of a good piston packing, and it would take some time to name all the patented and unpatented devices that have been used for this purpose. On the other hand, some prominent engine-builders make solid pistons, and rely upon grooves and excellent fitting to render them steam-tight when running. The latter are growing in favor, and for high-speed engines they entirely fill the bill. The water condensed in the grooves can not be forced out in the time of a single stroke, and therefore opposes an impassable barrier to the steam. But, with or without packing, a piston will leak, unless the cylinder be cylindrical and of uniform diameter throughout. Unequal expansion may affect the roundness of the bore, and cylinders are frequently sent out that never had a round uniform bore. Cylinders also wear out of round. Hence, when Mr. Kearney proposes to test the tightness of a piston by turning an engine onto its dead center, taking off the head at the opposite end of the cylinder, and watching at the open end for leaks, he names a

common, but yet imperfect, way of testing. The method tests tightness only in the two extreme piston positions. By using a stout clamping bar, bolted to the cylinder flange, the test described may be made for any piston position. Tested in this way, it may be found that the piston, tight in one place, may leak in another, thus indicating that the cylinder is not of uniform bore.

Mr. Kearney describes the usual makeshifts for tightening ring-packing. These are good things to know, but, if proper fitting, in the first instance, has been done, and adequate care and skill have been applied in use, they will not often be needed.

Passing other practical remarks relative to counterbores, follower bolts, etc., the hint that a small quantity of good cylinder oil is of more service in cylinder lubrication than a flood of an inferior lubricant ought to have been supplemented by the statement that a uniform small supply of oil to the cylinder at short intervals is far more effective and economical than a larger quantity put in at longer intervals. A good sight-feed lubricator which supplies the oil drop by drop is the most perfect appliance yet devised for this purpose.

Remediable Losses in Belt Driving.

THE losses in transmitting power by belts are, on the average, much larger than is commonly supposed. Excess over the necessary losses is in most cases the result of faulty design and construction. Mr. M. W. Danielson has recently presented in *The Age of Steel* an estimate from four different mills, which is cited here as substantiating the statement that such losses are underestimated. He found the percentages of total power applied to shafting used in driving the belts and shafting in these mills to be respectively 22.7, 39.2, 25.6, and 23.6. Between the highest and lowest of these percentages there is a difference of 16.5 per cent. of the total power used, to be accounted for only on the supposition that the design and construction are better in one case than in the other.

There has been of late years a tendency toward using narrower belts and pulleys; but we are unable to see that any saving in friction could have been made in this way, unless the belts and pulleys previously used were of widths in excess of what was needed. Belts and pulleys should be proportioned to their work,—neither too narrow nor to wide. Excessive width means excessive weight and increased friction. If a belt is so narrow that it must be run with great tightness to do its work, this also means increased pressure on bearings and increased friction. So one may err in exactly opposite directions. We agree with Mr. Danielson that the conditions under which narrow belts and pulleys are used are seldom the right conditions, and that for general purposes narrow belts and pulleys are to be avoided.

The system of running line shafting at high speed, when proper attention is paid to lubrication, is undoubtedly economical; but this demands accurate alignment, and careful attention to constructive details. Perfect solidity in supports, perfect alignment, good oil constantly supplied to bearings, belts, and pulleys of such width that belts can do their work when running reasonably slack,—these are the great secrets of the economical transmission of power by belting.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

6524. Molding Machines and Air Hoists. John Randol (Illustrated description of machines and processes). Am Mach–June 11. 1400 w.

6561. Transmission of Power (M. W. Danielsen (The losses due to friction in belt driving are shown to be much larger than are generally supposed, and practical suggestions for reducing them are presented). Age of St–June 13. .600 w.

6614. Pattern Shop Costs. A. Sorge, Jr. (A method of ascertaining cost of pattern shop work, classified and in a readily comparable form, and one which also indicates the efficiency

We supply copies of these articles. See introductory.

of the department. The method, though restricted in this article to wood patterns, can easily be extended to metal pattern work). Ir Age–June 18. 6000 w.

6640. Molding Bronze Tuyeres. George O. Vair (Illustrated description of flask core box mold and process). Am Mach–June 18. 700 w.

6748. Peculiar Planing. John Randol (Illustrated description of a method for finishing concave surfaces on a planer, and of a method for planing rod-straps on the inside). Am Mach–June 25. 1400 w.

6786. Power of Blast Penetration and Improvements in Center Blast. Thomas D. West (Read at meeting of Western Foundrymen's Assn. Experiments with and arguments in favor of the use of the center blast in melting, with illustrated description of improvements in the method, and discussion). Ir Tr Rev–June 25. 5300 w.

6817. Setting Valves of Locomotives. Fred E. Rogers (Description of method). Am Mach–July. 1200 w.

6818. Sand-Sifting Machine. John L. Klindworth (Illustrated description). Am Mach July. 250 w.

6827. Key-Seating on the Planer. John F. McNutt (Illustrated description of method in which the cutting is done by broaching tools). Am Mach–July 2. 400 w.

6838. Modern Boiler Making Contrasted with Old Methods. Henry J. Hartley (Paper read at the convention of the Am. Boiler Mfrs.' Assn. Past and present of boiler building. Treatment wholly practical). Ir Age–July 2. 2500 w.

6840. Strength of Tubing. Oberlin Smith (The lack of data and the urgent need of more light upon this subject and agreement upon standard specifications are topics discussed). Ir Age–July 2 1000 w.

Steam Engineering.

6537. The Efficiency of Steam Boilers (Brief editorial review of papers upon this subject read before the American Society of Mechanical Engineers, at three successive meetings, of discussions upon these papers by members, and articles, letters, and discussions in technical journals elicited by them). Eng News–June 11. 1800 w.

6563. Experiments with Boiler Coverings (Experiments directed to a comparison of mica boiler covering with those of other kinds, in which mica was found superior to any other material. The experiments were carried out in the Mechanical Department of the Canadian Pacific Railway. A diagram showing graphically the results is presented). Can Eng–June. 1200 w.

6574. Direct Graphic Determination of Initial, Terminal, and Cut-off Pressures, in the Trailing Cylinders of Multi-Expansion Engines Having Fixed Cut-offs. Charles M. Jones (Full description of method with diagrams). Elec Engng–June. 2700 w.

*6602. Constants for Steam-Engine Design. W. S. Goll and L. J. Gray (Account of an investigation instituted to derive from reliable data constants to be used in steam-engine design). Sib Jour of Engng–June. 1100 w.

*6604. A Study of Initial Condensation. Arthur L. Rice (An attempt to find a convenient and accurate formula expressing the probable amount of condensation at admission of steam into an engine cylinder). Sib Jour of Engng–June. 1000 w.

*6605. Engine Valve Friction. W. A. Gordau and F. H. Hazard (Experimental research with tabulated data). Sib Jour of Engng–June. 1000 w.

*6607. Initial Condensation. E. T. Adams (Experimental work upon this subject in progress at Sibley College). Sib Jour of Engng–June. 900 w.

6610. Erection of the Corliss Engine. Paul Stapanskey (Detailed description of a method whereby rapidity and rigidity in erection, together with proper alignment of parts, etc., are secured). Safety V–June. Serial. 1st part. 900 w.

6611. The Store and Office-Building Engineer. W. L. Patterson in *The Inland Engineer* (Necessary qualifications for engineers in stores and office buildings, and a criticism of the growing tendency to employ one man as chief-engineer, consulting engineer or electrical engineer for a number of places). Safety V–June. 1000 w.

6612. The Steam Pump and Water Pipes. C. A. Collett (Methods of computing flow and delivery, horse-power needed, etc). Safety V–June. 5000 w.

6613. Something about Packing. W. H. Wakeman (A practical dissertation, giving many useful hints). Safety V–June. 2800 w.

6618. The Variation of Steam Engine Economy with Change of Load. W. F. Durand (A careful study and graphic representations of the variations and causes of economy in engines working under variable load, with tabulated data). Am Elect'n–June. 2500 w.

†6657. The Temperature Entropy Diagram. G. A. Goodenough (A brief résumé of the most interesting properties of the $T'\phi$ diagram in thermodynamics). Tech–May, '96. 2200 w.

*6689. Steam Engines for Direct Connected Electric Generators. E. A. Sperry (Illustrated description of a new design of an engine for direct connected electric generators). Jour Assn of Engng Socs–May. 2200 w.

*6727. Powdered Coal for Firing Steam Boilers: Wegener and Other Systems. Bryan Donkin (Read at meeting of Federated Inst. of Mining Engs., London. Combustion and air supply; analysis of gases; boiler efficiency; transmission of heat, &c. Systems of powdered coal firing now in use in Germany. Practical applications of the Wegener system to boiler firing. Description of the system and experiments therewith. Summary and discussion. A very able and thorough paper). Col Guard–June 12. 4200 w.

6830. Metallic Stuffing-Box Packing. Edwin N. Wiest (A two-ring packing, illustrated

and described, with composition of alloy for such packings). Am Mach–July 2. 450 w.

6842. The Passing of the Engine Runner (The effect of large power plants upon the occupation of engine runners, the number of which is annually decreasing). Power–July. 1200 w.

6861. Mechanical Stokers (A comparison of various stokers). Bos Jour of Com–July 4. 1800 w.

*6868. The Calorific Value of Coals. E. Goutal (From the "*Revue de Chimie Industrielle.*" A method for determining the calorific value of coal thought to be of sufficient accuracy, but which does not involve the use of a calorimeter). Prac Eng–June 26. 700 w.

6898. An Interesting Power Plant (A description of an ingenious way of enlarging an old foundation for a steam engine by the use of railroad iron). Eng Rec–July 4. 800 w.

6969. A German Mechanical Stoker (Illustrated description). Eng News–July 9. 300 w.

Miscellany.

6531. The Manufacture of Coke and Its Selection for the Foundry. W. T. Rainey (Read before the Foundrymen's Assn. Abstract. The process of coking and method of charging the ovens in the Connellsville district is described, and brief reference made to another process, used a great deal in Europe). Ir Age–June 11. 1600 w.

6532. Some Interesting Piston Rods. H. K. Landis (A most interesting description of hollow piston rods that failed on the great steam hammer at Bethlehem, Pa., and of a final one of nickel steel that has stood since 1892). Ir Age–June 11. 1000 w.

6641. Some Compressed-Air Victims. Frank Richards (Past failures in air propelled street cars, and their causes). Am Mach–June 18. 1800 w.

†6670. Stresses and Deflections in Circular Rings under Various Conditions of Loading. Claude W. L. Filkins and Edwin J. Fort (A mathematical investigation with formulæ and diagrams. Previous literature of the subject is referred to). Trans Assn of Civil Engs of Cornell Univ–June, '96. 4300 w.

*6687. Metrological Standards and Gauging Implements. J. Richards (A very interesting historical sketch, presenting facts relating to grinding calipers and gauges that are not generally known). Jour Assn of Engng Socs–May. 5000 w.

*6688. Economy in Combustion and Smoke Prevention. C. F. Mabery (The subject is treated from both chemical and mechanical standpoints. Discussion). Jour Assn Engng Socs–May. 5800 w.

6708. Hydraulic Rams. Carl Pixis (Illustrated description of three varieties of a new kind of hydraulic ram, recently exhibited at the Paris Agricultural Exhibition). Eng & Min Jour–June 20. 1000 w.

*6785. The Art of Bronze Casting in Europe. George Simonds (History and hints upon the molding and casting of artistic works in bronze). Jour Soc of Arts–June 19. 13500 w.

6853. Power for Motocycles. Leland L. Summers (A discussion of the advantages, and a comparison of results, of the gas engine, or internal combustion motor, and the electric motor). Elec Engng–July. 3400 w.

6865. Some Experiments on the Strength of Leather. Walter G. McMillan (Description and results of mechanical tests made by the Indian Ordnance Department, to determine the tensile strength of harness leather. Discussion). Leather Mfrer–July. 2800 w.

*6867. Producer Gas and Gas Producers. A. H. Sexton (The first part treats the subject from the chemical standpoint). Prac Eng–June 26. Serial. 1st part. 4500 w.

6874. Centrifugal Pumping. J. Richards (Review of progress). Eng News–July 2. 1200 w.

6876. Locomotive Counter-Balancing (From a committee report presented at the annual convention of the Am. Ry. Mas. Mech's Ass'n. Epitome of practice as collected by the committee through correspondence). Eng News–July 2. 1000 w.

6881. Improvements in Standard Machines. Payson Burleigh (The author points out that a large number of so-called improvements upon standard machines are not improvements, and that their purpose is simply to aid in sales, the machines being in many cases no better, and in some cases not so good for the additions). Age of St–July 4. 2400 w.

†6901. Utilization of the Anthracite Culm Heaps in the Production of Power. Nelson W. Perry (The vast amount of mechanical power now latent in the heaps of unutilized culm, and the feasibility of utilizing this power is the subject discussed). Jour Fr Inst–July. 6500 w.

†6928. The Invention and Development of the Masticator (A machine used for breaking down or milling crude rubber is described by the inventor, Thomas Hancock). Ind Rub Wld–July 10. 2000 w.

†6931. The Export of American Bicycles and Tires (The encouraging outlook for this industry, with table of details of bicycle exports from New York for the three months ending June 30). Ind. Rub. Wld. July 10. 1600 w.

6961. The Efficiencies of Air Compressors. C. P. Paulding (Review of some points in articles which have recently appeared in American Machinist. The possible and actual in air compressors). Am Mach–July 9. 1200 w.

6962. Wire Rope Haulage. T. E. Hughes (Read before the Ohio Inst. of Min. Engs. Practical points in the use of wire rope, in which it is asserted that a general rule as to manner of operation is impracticable, and a statement of conditions requiring special treatment is made). Min Ind & Rev–July 2. 2500 w.

6972. Safety in Locomotive Boiler Construction (Editorial explaining and discussing the differences between radial stay boilers and crown-bar boilers, with general comments). Eng News–July 9. 1200 w.

MINING & METALLURGY

A Wail From the Australian Gold Fields.

A VERY promising young gold boom in western Australia, according to some accounts, is on the verge of perishing from thirst in "a dry land where no water is." The situation is so serious, in the eyes of *The Mining Journal, Railway and Commercial Gazette*, that it devotes space in a recent issue to a breezy letter from Mr. Raymond Radcliffe, a technical report from Carl Schmeisser, and two editorials,—all bearing upon the one topic.

"Water, water alone," cries Mr. Radcliffe, "means dividends," and this is to be taken in its literal and material sense, and not in that usually attached to the term in "the street."

"Indeed," he says, "so rich in reefs is west Australia that there is absolutely no demand for 'wild-cats.'" "The gold mines of west Australia are so rich that neither dear labor, nor expensive food, nor high rates of carriage can stop the progress of the country, once the water question is settled." "No man prospecting in the country need fear of finding reefs. As to whether these reefs will pay to-day is another question."

From Mr. Schmeisser's report the difficulty appears to be concentrated in the southern districts. He says: "Whilst there is, particularly in the northern and western gold fields, generally a sufficient quantity of water for milling purposes to be obtained at depths of only 70 or 80 feet, milling in the southern districts, as far north as the East Murchison gold fields, meets with the greatest difficulties on account of the universal scarcity of water in that country." And this leads Mr. Radcliffe to the sad conclusion that these wonderfully numerous and rich reefs "are simply mines which will not pay, until some good water scheme has been established. Bayley's Reward has many thousands of tons of one-ounce stone which today will not pay for crushing, but which would pay splendidly, if Coolgardie had as much water as they have at Charters Towers, where in the early days there was no water at all. At the 90 Mile there are literally millions of tons of quartz waiting for ample water-supply, the Caledonian Mill being only run upon the richer stone in the mines.

"At the Black Flag Proprietary there is stone enough to keep a 100 head battery going for years; but here again they will not be able to run more than 20 or 30 with their present supply. At Hannan's the water difficulty is acute. I have mentioned the 90-Mile, Black Flag, because in these places the water is more plentiful than upon any other camp in the field, except, perhaps, Menzies. But Hannan's is the field *par excellence*. Here the reefs are both wide and rich; here no one seems to make a mistake; the whole 10 miles of reefs are marvellously rich. *Cui bono?* No one can crush. The Great Boulder ekes out a splendid existence by mining the wet ore from the 200 feet level, with the drier lode taken from above the 50 feet. It runs its 10 head steadily enough, and it also runs 10 head in the Lake View when it can. It has just about enough water to keep a 20-head going. The Great Boulder is the only mine with a constant water-supply drawn from the so-called lake, which is only a salt pan with a granite bed in which the water is held.

"The Brownhill has taken its fate in both hands, and its dry-crushing plant may succeed, but it will be a bold man who prophesies success here. Lake View, with its schistose quartz mixed with kaolin limestone, will take 30,000 gallons a day to keep its 20-head going, and they have no earthly chance of getting half this amount. Ivanhoe and Iron King have just enough water to crush six months out of the twelve. Few of the other Hannan's properties can count upon more than a few thousands gallons of water a day.

"Now I ask: Can this state of affairs continue? Is it reasonable? Here we have a magnificent series of mines, 'rich beyond the dreams of avarice,' and nearly

all lying idle for want of water. I say that it is not a question for private enterprise, but a national question.

"Water cannot be obtained in western Australia unless some one—either the government or a big corporation—does put down from five to ten millions. The capitalist cannot run the risk. The government must, therefore, do the thing themselves. They have no choice."

This certainly seems about as remarkable a conclusion as could well be reached from the premises which Mr. Radcliffe himself has laid down, and suggests the converse of an often-quoted proverb; perhaps those whom heaven helps too much lose the power of helping themselves.

A more startling instance of the tendencies of State Socialism could hardly be found than is here afforded by the calm assumption by the writers in *The Mining Journal* that it is the unquestioned duty of the government to step in and do anything that capital is too timid or too lazy to do for itself. They are so perfectly frank. Mr. Radcliffe says: "The reason I write this is to urge upon the London shareholders to combine to force this water question upon the government."

And all this in spite of the evidence that the advantage would not even be general. To quote Mr. Schmeisser again: "Seeing, however, how large is the area of the goldfields, and how scattered the mines are in them, it is quite natural that only the main groups of veins could participate in this advantage. The solitary and the distant mines will have to rely, then as now, upon their own water-supplies. For these it will be indispensable to employ only such processes as can work with the minimum possible consumption of water."

It is hard to share Mr. Radcliffe's concern for the owners of these miles of "marvellously rich" reefs, where "no one seems to make a mistake," who now demand that an equally beneficent protective influence shall secure for them, without any risk to themselves, all the needed necessary conditions. A sturdier type seems to be developed in countries where the government is not so confidently expected to act as a sort of supplementary Providence.

The Year's Production of Silver.

THE statistics of the world's silver production for the year 1895, as presented by *The Engineering and Mining Journal*, will be a surprise to those readers whose impressions have been formed chiefly from the daily press. The general impression that the industry was stagnant has been cultivated by both sides in the financial controversy, though their attribution of causes and their inferences have been diametrically opposed.

Curiously, too, mining and metallurgical literature has favored the same conception although quite innocently. So much interest has been excited by recent developments of gold properties that these have naturally taken the first place. Australia has succeeded the Transvaal, and, among our English contemporaries especially, has eclipsed everything else; and silver has been as subordinate in technology as it has been prominent in politics.

The figures reviewed in the *Journal*, however, correct these misapprehensions, and "put the total production of silver in the world in 1895 at 181,850,731 fine ounces (5,651,962 kilograms),—an actual increase of 3,182,630 fine ounces (97,818 kilograms) over 1894. In the United States, while there was a small decrease last year—3,515,640 ounces, the total for 1895 being 46,331,235 ounces—in the silver produced from native ores, there was a large increase in the silver smelted or refined from imported ores and bullion, and the total quantity of metal put into marketable shape in this country last year was 76,437,071 ounces, or actually 6,247,485 ounces more than the similar total for 1894. These figures show that the silver producers have not been idle, and warrant the presumption that they have not universally been working at a loss."

The data of our own mines are the most unexpected. The clamor of the silver agitators would naturally create the impression that the mines were nearly or entirely idle: instead of this, the output was only about seven per cent. short of that of the preceding year,—far from a bad record, considering the depression experienced in all lines of business and indus-

trial venture. And the smelters, it will be noticed, made up this loss, and more besides.

It is rather remarkable that, in spite of the increase in total production, the price of silver has marked an almost unbroken advance from 59.69 cents per troy ounce in January, 1895, to 68.69 cents in June, 1896.

As to future prospects, the *Journal* says:

"The production of silver is evidently not continued on hope alone, since some of our own larger mines were able not only to keep at work, but to pay dividends also, and the same thing can be said of a number of the Mexican mines. While it is entirely impossible to fix on any average of the cost of producing silver, it is evident that, for an output of, say, 45,000,000 ounces in the United States, it is at present below 65 cents an ounce.

"While no very large increase in the production of silver is probable under existing conditions, and while these have very much discouraged prospecting for and opening new mines, it is altogether likely that the present rate of production will be maintained for a time. There is, at any rate, no reason to look for a material decrease for some years to come, while the Mexican and South American mines continue to be worked at the present rate; the Broken Hill mines in Australia are arranging to increase their output by working on a large scale the sulphid ores, which have hitherto been neglected; and, finally, while the important part of the silver output which is won in connection with copper, lead, and other metals is increasing."

The Hygienic Relations of Coal Mining.

THE COLLIERY GUARDIAN has some information on the subject of mortality and health among the coal miners of Great Britain which, in its summary, is strangely contrary to the general belief.

It is safe to say that the occupation would be classed at least "extra-hazardous" by insurance companies, and, in the popular conception, the coal miner carries his life hanging by a thread,—a stick of dynamite in one hand and an open flame in the other.

It is, therefore, more than surprising to read that, "according to the forty-fifth annual report of the registrar-general, the mortality of miners is less than that of the general aggregate male population." The statement, however, appears to be clear and definite, and is evidently official. It is repeated in an extract from a letter from Dr. Ogle, embodied in the same report, to the effect that "the death-rates of miners are surprisingly low. In spite of their liability to accident, the comparative mortality of these laborers is considerably below that of all males."

When the *Colliery Guardian* goes into an analysis of the figures, however, it plunges into a labyrinth of perplexity to which the clue seems to be lost. Here are the statements *verbatim;* let the reader work out his own solution who can. "The registrar-general states that the mortality of miners (including accidents), is 883 per 1,000, as compared with 1,000 of all males of the population (including accidents). The full figures are the following: the deaths per 1,000 of all males are 933, and the accidents 67, together 1,000. For the miners the deaths from ordinary causes number 697, and from accidents 186, together 883; so that there are less deaths per thousand amongst the miners than amongst the general male population."

That the deaths and accidents among "1,000 of all males of the population" will eventually be "together, 1,000" is beyond peradventure; but, if the statement be taken in this sense, we should have to infer that among the miners only 883 of every 1,000 died at all, and the rest emulated the patriarch Enoch or realized the adjuration of the Persian courtiers to their king and "lived forever." To construe the figures as annual returns would involve the peculiar conclusion that all the males in the kingdom died off each year, except among miners, where about 117 per 1,000 survived into the next season. The *Guardian* will have to supply the proverbial "diagram." To return to more comprehensible propositions, Dr. Ogle considers that, if we "exclude the accidents, the mortality of the coal miners only slightly exceeds that of the most healthy class of

men in our land,—namely, the agriculturists; that is to say, the agricultural laborers, the farmers, and the gardeners." And the accidents do not seem to be so numerous or so fatal as the public supposes.

"On August 15, 1890, a return was made to an order of the house of commons which showed that, out of a total number of 581,809 persons employed in coal mines, the proportion of persons injured was 7.36 per 1,000. It is true, Dr. Le Neve Foster makes the number higher, but he relies on an hypothesis, and he takes in slight accidents. Of the number of men killed, the proportion per 1,000 in 1893 and 1894 was 0.9."

These general figures are nearly borne out by the report of her majesty's inspector of coal-mines for Yorkshire and Lincolnshire, where about 90,000 persons are employed. From this it appears that the accidental deaths in 1895 were only one to every 977 miners, or to every 256,258 tons of mineral produced.

In support of the healthfulness of the occupation, a "medical man" is quoted to the effect "that in certain districts the mining population was entirely exempt from the terrible disease of cancer, to which the rest of the population round about them and in the midst of which they lived were liable; and that this was attributable to the habits of cleanliness necessarily engendered by their occupation." In other words, it must be healthier to get very dirty indeed and then wash than to keep moderately clean all the time.

The Peruvian Oil-Fields.

THE AMERICAN MANUFACTURER publishes some information concerning the petroleum output of Peru, derived from a paper originally prepared by Dr. H. Polakowshy of Berlin, translated into Spanish for *La voz del Sur* (Lima) and retranslated thence for the *Manufacturer*.

The data appear to have suffered a little here and there, possibly in their linguistic double somersault; for their insufficiency, however, the responsibility attaches solely to the revolutionary disturbances of the country and the temperamental lack of energy among its officials. Some figures, Dr. Polakowshy states, were published by the government engineer, Federico Moreno, in the *Bulletin of the Lima Geographical Society* in 1893; but the political unsettlements following seem to have stopped the work. The figures given by Dr. Middendorf, Moreno's coadjutor in the collection of the latest statistics, are as follows:

"In 1885, 650,000 liters were produced; in 1888, 1,001,000; and in 1891, 2,802 000. In 1892, 49 wells produced 500,000 barrels of 160 liters each (3¾ liters=1 gallon); the United States produced in the same year 15,000,000 barrels. The Peruvian oil field is located in the department of Piura near the coast, extending from Punta de Aguje to Tumbes,—a distance of more than 400 miles. The country is very sparsely settled, practically an arid waste."

"The region has not been thoroughly explored yet. According to an estimate made by E. P. Larkin, New York, 1866, an American engineer, who lived three years in the province of Tumbes, the oil district comprises an area of 7,200 square miles. Mr. Faiville (Petroleum, Paris, 1818) estimated the area of Tumbes at 16,000 square kilometers, while the estimates of F. Hue and B. Creso agree with that of Larkin. All these explorers locate the oil district between Cabo Blanco, 50 miles north of Paita, and the Charan range, about 10 miles south of the Tumbes river. This district may be considered the greater part of the northern oil region. Besides, petroleum deposits have been found at other points along the coast. The only thing lacking in the development of these natural resources is energy."

Mr. Moreno estimates the area of the entire Peruvian oil field at 32,000 square kilometers, which he divides into three zones:

"1. The northern field from the province of Tumbes to the Mancora range and 100 miles from the Tumbes river.

"2. The central field from Punta Soco, in the Mancora range, to Punta de Lobos.

"3. The southern field, extending from 400 to 16,000 meters from the coast, between 80.58° and 81.11° longitude and 5.41° and 6.10° southern latitude. This field is

traversed by several mountain ranges of 1,200 feet height, which end at the Punta Pisura on the Sechura bay. In wet years these hills furnish good pasture; there are also several good harbors in this district."

"The oil wells in all these fields are less than 800 feet deep. Oil has been found at some places even at a depth of but 30 feet. The wells are located on the side of a hill or in a ravine, so that the oil can easily be collected at some lower place.

"According to Moreno, it is necessary, in reaching the real geological oil strata, to drill to a depth of 1,200 feet, and only then can a definite success be expected when gas commences to escape. The pumps are required when the wells are drilled deep. In the Tumbes district the wells are all located in the plain, and, when one is exhausted, another one is drilled. These wells were not very productive, but the producers were forced to adopt this method of working, because until 1888 proper machinery was lacking completely. It is more convenient to drill the wells at the foot of a hill or in the mountains."

"The Tumbes as well as the Negritos field, which is now being explored, is level. The surface strata consist of conglomerate."

This level country must interfere with the convenience of the energetic prospectors who prefer a situation where even the crude oil can be spared any labor, except that of sliding down hill.

The development, however, seems to be progressing, largely under the stimulus of English capital and engineering skill, although Mr. Moreno recommends that the petroleum industry be made a government monopoly.

"Crude oil is being used, instead of coal, as fuel for the locomotives on all Peruvian railroads, as well as in many manufacturing establishments and gas works. The price is 20 soles (about ten dollars) per ton. It is a cheap fuel, and has scored a great success. Large quantities are exported to Chili for the same purpose. All the companies now engaged in developing the oil fields are strongly organized in financial respect. The most prominent are: Zorritos, capital £100,000; Talara, £250,000; and Heath, £25,000. There are a number of others of less importance: the Peruvian Petroleum Company, capital, £20,000; the Mancora Peru Petroleum, £12,000; the Union Petroleum Syndicate, £10,000. The works nearest to the Tumbe river belong to F. G. Piaggio, to whom a gold medal was awarded at the South American Exposition of 1884."

One of the most curious points noted is "the discovery by the English engineer Chenhall that, by adding to boiled petroleum Quillaya root (38 grams of the root to 1,000 grams oil) the oil can be changed into a solid substance, the transport being greatly facilitated." The oil itself, as shown by the subjoined analyses, is very similar to the Russian, and quite different from the American petroleum.

	United States per cent.	Russia. p. c.	Peru. p. c.
Carbon	49.1	87.4	84.9
Hydrogen	6.3	12.5	13.7
Oxygen	44.6	0.1	1.4

It certainly seems to offer an excellent opportunity to the "men and energy" whose absence Mr. Moreno deplores.

Two Investigators of Irrespirable Air.

A CURIOUS study of highly contrasting investigations of similar phenomena is afforded by a comparison of two papers recently noticed in mining exchanges.

The first, abstracted in brief in the *Engineering and Mining Journal*, was presented by Frank Clowes, D. Sc., at a recent meeting of the British Association, and embodies the results of Dr. Clowes's experiments on the "Respirability of Air in which a Candle-flame is Extinguished." Mixtures of air, nitrogen, and carbon dioxid were prepared, tested, and varied, until it was found that a mixture of about 16.5 per cent. of oxygen and 83.5 per cent. of the extinctive gases would just extinguish a candle. Conversely, the residual gases, after allowing a candle to burn to extinction in pure air confined over mercury, were found to present almost this same composition. "Now, an atmosphere of this

composition," says Dr. Clowes, "is undoubtedly respirable. Physiologists state that air may be breathed until oxygen is reduced to 10 per cent. The maximum amount of carbon dioxid which may be present is open to question, but it is undoubtedly considerably higher than 3 per cent; the conclusion to be drawn from these facts is that an atmosphere must not be considered to be dangerous and irrespirable because the flame of an ordinary candle or oil lamp is extinguished by it. The view is very generally advanced that a man must on no account venture into air which extinguishes the flame of a candle or of a bundle of shavings. It will be seen that this precaution may deter one from entering an atmosphere which is perfectly safe and respirable, and from doing duty of a humane or necessary character."

Unfortunately, it will immediately occur to most readers that the "air which extinguishes the flame of a candle or a bunch of shavings" may obstinately be much more than "just able to extinguish" this flame. Not only Dr. Clowes's experimental mixture of "16.5 per cent. of oxygen and 83.5 per cent. of the extinctive gases," but every mixture worse than this, will be equally efficacious, and all that the experimenter can learn from the test is that the atmosphere in question contains certainly as little as 16 per cent. of oxygen, and maybe none at all; nor will he gain any information as to the other poisonous gases so often present in the doubtful cases which Dr. Clowes professes to aid.

Any effort in furtherance of "humane or necessary" work is commendable, but it is hardly likely that the would-be rescuer who sees his test flame extinguished will gain much encouragement from these laboratory results. Further, the sad history of accident and rescue suggests rather the need of restraining reckless bravery than of encouraging additional risk.

Very different is the tone of the second paper, prepared under parliamentary auspices by Dr. Haldane, whom Dr. Clowes quotes, and published in *The Colliery Guardian*. It is based upon stern and grewsome data—"the bodies of the men and horses killed at Tylorstown"—"from the examinations of the bodies found in all parts of the pit, and from the symptoms of the rescuers." The most significant feature of the difference is that, far from searching for conditions under which the ordinarily-accepted danger-signs may be disregarded, Dr. Haldane is continually alert to devise means of detecting the danger which may lurk behind apparent indications of safety; to find the minimum of injurious gases which can be detected, not the maximum which can be endured.

He dwells especially upon the poisonous effects of carbon monoxid, to which he attributes the larger share of the terrible death-roll from colliery accidents, and emphasizes the fact that its recognition "is a matter of much practical importance, and many lives have been lost through ignorance of the fact that the lamps—to which miners trust for the recognition of other gases—give no direct indication of carbon monoxid." He calls attention to the particular dangers arising from the fact that it is insidious in its action, and may suddenly overcome a man when he has progressed so far into the vitiated atmosphere that he can not make his way back; advises such disposition of relief parties that a reserve may always be at hand; and suggests the keeping and carrying of mice in suspected places, as they show the symptoms of carbon monoxid poisoning very much sooner than men.

He gives some space also to sulphurous acid,—another poisonous gas which has no effect on the flame; carbonic acid he exhibits as an active anesthetic poison, not merely (as generally supposed) a mere diluent of the air.

Instead of seeking reassurance from the fact that a certain mixture may extinguish a flame and yet support respiration, he publishes investigations showing the possibility to have a combination of oxygen and carbon dioxid in which a flame will burn while a man would be rapidly overcome.

Probably he would unhesitatingly endorse Dr. Clowes's closing deduction that "undoubtedly the candle and lamp flames should be discarded as absolute tests of the respirability of air," but there would be a world of difference in his meaning.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*6705. The Bessemer Steel Industry of the United Kingdom in 1895 (Statistics collected from the manufacturers by the British Iron Trade Assn. in regard to the production of ingots, of Bessemer steel rails, of finished steel, and extent of employment of plant). Ir & Coal Trds Rev–June 12. 1000 w.

*6706. The Open-Hearth Steel Industry of the United Kingdom in 1895 (Statistics dealing with the production of ingots, of finished open-hearth steel, and of open-hearth furnaces, with a comparison of British and American output). Ir & Coal Trds Rev–June 12. 900 w.

6715. Manganese and Manganiferous Ore in Spain. Reginald W. Barrington (Brief accounts of the districts producing the largest quantities during 1895, with analysis of the ore). Am Mfr & Ir Wld–June 19. 400 w.

†6796. Improvements in Gold Extraction. H. Livingstone Sulman, with Discussion (Detailed description of results of experimental work relating to some of the problems which have recently become prominent in the modern processes of gold extraction—viz., the application of an improved cyanide solvent to refractory ores; a new method of precipitating gold from solutions of potassic cyanide, and the leaching of slimes). Inst of Min & Met, Lond–Vol III Pt II. 22500 w.

†6856. The Sulphuric Acid Process of Refining Lixiviation Sulphides. Frederic P. Dewey (Read before the Washington Section of the Am. Chem. Soc. A description of the Dewey-Walter process with summary of statistics). Jour Am Chem Soc–July. 3400 w.

†6857. Notes on the Electrolytic Determination of Iron, Nickel and Zinc. H. H. Nicholson and S. Avery (Results of investigations). Jour Am Chem Soc–July. 1700 w.

*6952. The Accumulation of Amalgam on Copper Plates (Facts observed in the 50-stamp "combination" mill operating the Drum Lummon mine, situated at Marysville, Montana). Aust Min Stand–May 21. 1800 w.

6976. Methods in Use for the Analysis of Ores, Pig Iron and Steel by the Carnegie Steel Co. John S. Unger (Report in response to a request from the Chemical Section of the Engineers' Society of Western Pennsylvania asking for the co-operation of chemists in an effort to collect for publication the methods in general use for the analysis of ores, pig iron and steel). Eng News–July 9. 4000 w.

Mining.

6562. The Effect of Trap-Doors in Mines; their Use, Abuse, and the Extent to Which They May be Avoided. James Blick (Read before the joint meeting of the W. Penna. Central Mining Inst. and the Ohio Inst. of Mining Engs. Favoring the treble entry system, and setting forth its advantages). Am Mfr & Ir Wld–June 12. 1900 w.

*6577. The Position of the Coal Dust Question (Review of the question, experiments and investigations, especially the investigations of Mr. Donald Stuart of the explosion in Camerton Colliery). Col Guard–June 5. 3500 w.

*6589. Methods of Opening and Working Coal Mines (Deals with boring and sinking, with illustrations showing the plan of surface arrangements of the South Wilkesbarre Colliery). Ir & Coal Trds Rev–June 5. 2000 w.

*6590. Haulage in Coal Mines (Description of the systems in operation, with reference to the account of M. A. Pernolet, of the mechanical appliances used in England and Germany). Ir & Coal Trds Rev–June 5. Serial. 1st part. 2800 w.

*6591. Coal-cutting by Machinery—Its Present and Its Future (Review of the history of the use of machinery in lieu of hand labor in mines). Ir & Coal Trds Rev–June 5. 3500 w.

*6592. The Lighting of Collieries by Electricity (The rapidity with which the electric light is being adopted for this purpose with account of installation and some difficulties, and examples where this mode of lighting is used). Ir & Coal Trds Rev–June 5. 2800 w.

*6594. Colliery Pumps and Pumping Operations (The rapid progress made in late years in this branch of colliery engineering, with examples especially of the application of electricity). Ir & Coal Trds Rev–June 5. 2500 w.

*6595. Electric and Other Safety Lamps (Brief illustrated description of various types). Ir & Coal Trds Rev–June 5. 1200 w.

*6596. The Screening and Washing of Coal (The importance of the mechanical preparation of coal, with description of screens in use). Ir & Coal Trds Rev–June 5. Serial. 1st part. 1700 w.

†6646. The Design of Top Work for Coal Mines. F. W. Rickart (The paper discusses top work only. Location, output, methods of grading, hoisting outfit and dumping are considered). Tech–May, '96. 4400 w.

*6721. Precautions Necessary in the Use of Electricity in Coal Mines. H. W. Ravenshaw (Abstract of a paper read before the Federated Institution of Mining Engineers. A few suggestions the carrying out of which may serve to minimize the risk both from shock and fire). Elect'n–June 12. 2900 w.

*6725. Dangers from the Use of "Safety" Fuse in Fiery Mines (From a communication to *Gluckauf* by Bergassessor Winckhaus, with reference to some observations by Bergrath Kaltheuner, of Gelsen Kirchen). Col Guard–June 12. 2600 w.

*6726. The Gobert Freezing Process of Shaft Sinking. A. Gobert (Read at meeting of the Federated Inst. of Mining Engs., London. Description of the direct freezing process). Col Guard–June 12. 2500 w.

*6754. The Coal-Fields of Kent (Illustrated description of the coal bed now being opened,

which has, at least estimate, an area 150 miles in length and 6 miles in breadth, and it is calculated that they will be capable of supplying 3000 tons a day for seventy years). Mach, Lond–June 15. 3500 w.

6767. Early Iron Mining in Michigan. William P. Kibbee (Historical account of discovery and early development). Ir Age–June 25. 2900 w.

6768. History of Cripple Creek (Briefly told from the day the first stake was put in the ground. Its early struggles and final success as a great gold camp. Ill) Min Invest–June 20. 4200 w.

6792. Improvements in Blasting Operations in Collieries. M. C. Ihlseng (Read before the joint meeting of W. P. C. M. I. and the O. I. M. E. A review of the different explosives in use, showing why some are unfit for use in certain mines, and urging improvement in the grade and greater care in the use of these materials). Am Mfr & Ir Wld–June 26. 2800 w.

6793. Petroleum in Peru. Dr. H. Polakowsky (A detailed description of the rich oil deposits which exist in certain parts of Peru). Am Mfr & Ir Wld–June 26. 1800 w.

†6794. Mining Reports and Mine Salting. Walter McDermott, with Discussion (Remarks against the indiscriminate use of terms familiar in mining reports, used as catch-penny phrases in a way to imply more than they really mean. The fixing of mines for selling and the danger from these sources). Inst of Min & Met, Lond–Vol. III, Pt. II. 15800 w.

†6795. Gold Mining and Milling in the Black Hills (S. Dakota). C. G Warnford Lock, with Discussion (General description, treating of the geological formation, auriferous veins and other deposits, the methods of mining and milling). Inst of Min & Met, Lond-Vol. III, Pt. II. 17000 w.

†6797. The Covadonga Manganese District and Its Mines. J A. Jones (Brief account of the discovery, situation, mode of occurrence, workings, cost of extraction, quantity, etc). Inst of Min & Met, Lond-Vol. III, Pt. II. 2800 w.

†6798. The Manganese Deposits of Huelva. Frank Johnson (Description of deposits). Inst of Min & Met, Lond-Vol. III, Pt. II. 3200 w.

†6799 Notes on the Espiritu Santo Mine at Cana; Its Drainage and Recovery. Ernest R. Woakes (Past history of the mine, account of exploration of the mine in 1892, and the more recent work It is a most interesting mine with an interesting history). Inst of Min & Met, Lond-Vol. III, Pt. II. 4500 w.

*6806. Mining Tenure in Western Australia. Raymond Radclyffe (Showing how the interests of investors are jeopardized by the anomalous state of the law, and emphasizing the necessity of reform). Min Jour–June 20. 1200 w.

*6807. The Present Position of Gold Mining in West Australia. Carl Schmeisser (A description of the studies of the writer on these gold fields. The first part deals with their geographical and geological relations and the auriferous deposits). Min Jour–June 20. Serial. 1st part. 4500 w.

*6810. Wilmotte Stops for Mine Cages (From a communication to the Liège Engineers' Association by M. Louis Eloy, engineer at the Kessales Colliery, Jemeppe, Belgium. Illustrated description, with a consideration of the conditions to be fulfilled by a good set of stops). Col Guard–June 19. 3000 w.

6823. Lead and Zinc Deposits in Iowa. A. G. Leonard (Brief account of the deposits, working of mines and output). Eng & Min Jour–June 27. 1900 w.

6825. The Gold Mining Industry in Georgia and Alabama. William M. Brewer (A review of the outlook in these fields, and the conditions affecting the industry). Eng & Min Jour–June 27. 1600 w.

*6879. Some Notes on the Mount Lyell Mine, Tasmania. Sydney Fawns (A paper read before the Inst. of Min. & Met. Treats of the history, natural features, ore deposit, mine workings, treatment of the ore, and costs). Min Jour –June 27. 2200 w.

*6880. The Copper Mines of Lake Superior. W. P. Kibbee (A statement of the prevailing conditions and some account of the surface workings of the Calumet and Hecla mine are given in part first). Min Jour–July 27. Serial. 1st part. 1600 w.

6903. Useful Effects of Air Splits and the Limits to Which They May Be Usefully Applied. Charles Connor (Condensed from a paper read before the joint meeting of the Western Penn. Central Mine Inst. and the Ohio Inst. of Min. Engs. The subject is discussed theoretically and practically; the advantages of air splits are stated and their limit in practice). Am Mfr & Ir Wld–July 3 1600 w.

6907. Cripple Creek Gold Production. Edward Skewes (A denial of some published statements, with corrections). Eng & Min Jour–July 4. 1500 w.

6908. A New Type of Mining Locomotive. Timothy W. Sprague (Illustrated description of a new type of mining locomotive built by the combined Baldwin and Westinghouse Companies). Eng & Min Jour–July 4. 800 w.

6909. The Electric Light in Mining Operations. William Baxter, Jr. (The advantages and disadvantages, cost, etc., efficiency and practicability). Eng & Min Jour–July 4. 1100 w.

6910. Gold Mining in the Appalachian Belt. W. H. Adams (Reviews the prospects, suggests the dividing of the territory into districts, commends paper on the subject by Messrs. Wilkins and Nitze, and states that the mine future of this belt must rest on ability to work low-grade ores). Eng & Min Jour–July 4. 2000 w.

6911. The Coal Beds of California. Harold W. Fairbanks (Notes stating briefly the occurrence of coal in this state and what the prospects are for the development of the industry). Eng & Min Jour–July 4. 1100 w.

6913. Coal Briquettes. N. G. Neare (One of the many ways of utilizing waste product). Tradesman–July 1. 2000 w.

*6927. Working Thin Seams in the Franco-Belgian Coalfield. M. F. Cambessédès (From a communication to the Société de l'Industrie Minérale. Describes working by shoots, and the working of very thin seams near ordinary seams and by forward stalls). Col Guard–June 26. Serial. 1st part. 3500 w.

*6938. Possible Economies in Coal Working (Discussing how far it is possible to introduce further economies and thus enable profits and wages to be improved). Ir & Coal Tr Rev–June 26. 2400 w.

*6939. Coal Miners and Their Work (Treats of the difficulties arising from mining disputes, and the increased safety of working). Ir & Coal Tr Rev–June 26. 1800 w.

*6941. Iron and Manganese. Arthur Lakes (Illustrated description of the great Cebolla River deposits. The location, geology, topography and development of the greatest beds of iron and manganese known in the world). Col Eng–July. 2400 w.

*6953. The Tate Tin Mines (Q.) W. H. Bain, in the *Wild River Times* (Description of the largest and most important of the stream tin-mining properties now being worked in North Queensland). Aust Min Stand–May 28. 900 w.

*6954. Rokeby Gold Mining Company, Gippsland (A brief account of a promising property). Aust Min Stand–June 4. 1200 w.

Miscellany.

*6506. The Utilization of Anthracite Culm. Ill. Edward H. Williams, Jr. (Showing the amount of culm sent to the dump, the ways in which it has been wasted, and the methods by which it may be made available for fuel purposes). Eng Mag–July. 3700 w.

6520. Asbestos. George Heli Guy (The importance of asbestos to the human race, its characteristics, where found, process of manufacture, uses, and newest departures). Elec Eng–June 10. 3400 w.

6526. Manufacture, Use and Abuse of Dynamite. H. A. Lee (The dangers of dynamite manufacture, the storage and age of powder, freezing temperatures, with a caution not to hurry back to a shot). Min & Sci Pr–June 6. 1800 w.

6535. Statistics of the Iron and Steel Industries (Review of the domestic iron trade as presented in the annual report of the American Iron and Steel Assn. A table compiled from figures given in the report shows in convenient form the condition of these and allied industries). Eng News–June 11. 1600 w.

*6579. Wire Mining Ropes. J. Bucknall-Smith. Their technology, manufacture and uses). Min Jour–June 6. Serial. 1st part. 1500 w.

*6597. The Cost of Producing Coal in Different Countries (The countries discussed are the United States, England, or Great Britain, Germany and Belgium). Ir & Coal Trds Rev–June 5. 1400 w.

*6685. The Land of Gold (Review of book by Julius M. Price on the West Australian gold field). Trans–June 12. 2500 w.

6716. Refractory Material. Walter Hempel and Waclaw Jezierski, in *Chemische Industrie* (Describes the results of an investigation of a peculiar mineral found in Norway, Southern Tyrol and the United States). Am Mfr & Ir Wld–June 19. 800 w.

*6728. On the Industrial Products of the Geological Formations of the United Kingdom (The first of a series of articles aiming to note and consider every strata which in any way affords employment for labor. This part deals with the products of the Pre-Cambrian and Archæan rocks, the Silurian and the Devonian). Col Guard–June 12. Serial. 1st part. 3800 w.

*6809. The Causes of Death in Colliery Explosions (Extract from a parliamentary paper, with special reference to Tylorstown, Brancepeth and Micklefield explosions. The report was prepared by Dr. John Haldane). Col Guard–June 19. Serial. 1st part. 8000 w.

6839. Regenerator Effects on Producer Gas. Jno E. Fry (Letter to the editor, containing discussion of paper by John H. Darby, and examining his views). Ir Age–July 2. 1000 w.

*6878. The Water Difficulty in Western Australia. Raymond Radclyffe (Its importance to the industry of mining and to investors. A statement of the condition of affairs with suggestions for conquering the difficulties). Min Jour–June 27. 1800 w.

6912 The Iron Products of Texas. James F. Fuller (An interesting paper on the iron interests of this great state read before a recent meeting of Texas Foundrymen). Tradesman–July 1. 1800 w.

*6942. Hoisting Machinery. William M. Morris (Illustrated description of a proposed modification of the Koepe system). Col Eng–July. 1700 w.

*6943. Mining Safeguards to Increase the Security of Miners (Valuable instructions from Bulletin No. 1, Colorado State Mining Bureau, by Harry A. Lee, Commissioner of Mines). Col Eng–July. 3500 w.

*6944. Economies in Mining by the Use of Mechanical Appliances. Cyrus Robinson (The advantages gained by their adoption, with statements of their economy and the conditions suited to the different kinds). Col Eng–July. 2900 w.

*6945. Doors in Mines. James Blick (Their effect on the air currents; their use, abuse, and the extent to which they may be avoided. Read before the joint meeting of the West. Penna. Cent. Min. Inst. and the Ohio Inst. of Min. Engs.) Col Eng–July. 2000 w.

*6946. Coal Handling. J. J. Ormsbee (Read at the meeting of the Eng's Assn. of the South. A description of the hauling and dumping plant at Pikeville, Tenn). Col Eng–July. 1500 w.

*6947. Fire Damp. F. C. Keighley (Read before the Ohio Inst. of Min. Engs. Experiences of a mine manager in some of the gaseous mines in the Connellsville, Penna., region, with deductions drawn from the same). Col Eng–July. 4200 w.

MUNICIPAL ENGINEERING

Ashes as a Source of Municipal Revenue.

IT has not been generally recognized that clean coal ashes might not be wholly a charge upon cities for their removal, and that, on the contrary, they might be made a source of municipal revenue. It has remained for one of the most intelligent and progressive street commissioners New York city has ever had, Col. George E. Waring, Jr., to bring this fact prominently before the public. This he has done in the last edition of his "Report on the Final Disposition of the Wastes of New York," just issued.

We have before had occasion to speak in praise of this model document, but will here take occasion to say that the present edition has been revised and enlarged, by additional discussions of practical topics, by the presentation of more complete information and data, and by a number of illustrations which the first edition did not contain.

Returning to the subject of ashes,—the amount collected in New York city is estimated at 1,500,000 cubic yards. Col. Waring says that, on account of the mixing of garbage with ashes, these ashes were made unfit for useful purposes. Hence their removal has been an unmitigated charge upon the city. Knowing that there was some demand for clean ashes, for filling, he studied the extent of the demand, and now clearly demonstrates that, if kept free from garbage, a considerable portion of the cost of their removal may be reimbursed to the city by their sale. The demand has been found to extend much further than for filling purposes. He says this study has convinced him "that clean ashes have become so valuable for building operations that contractors will gladly pay the small amount per cubic yard which will requite the city for storing the ashes at the dumping-stations for the few hours or few days that may be necessary at different times of the year, and which will, to the extent of the ashes thus used, leave the expense to the city only that of collection.

"The present cost of ashes delivered at new buildings is supposed to be merely the cost of hauling; but, while in cold weather the price is 25 cents per load of one cubic yard, it frequently rises during the summer to 60 cents per load, and is seldom less than 50 cents between March and November. This is due, of course, to the scarcity of ashes during nine months of the year; and I am assured by various builders that it would be a boon to them if clean ashes could be regularly procured at a small cost for storage, at the various department dumping-stations which, happily for builders' convenience, are well distributed along the river fronts. They say that under such circumstances the city's household ashes would be used as rapidly as made, certainly for six months of each year, probably for nine months. Those best fitted to judge are of opinion that the household ashes will be entirely suitable for builders' needs, though they differ materially in character and appearance from steam ashes."

One of the uses for clean ashes is in the laying of side-walks, flagging, etc. Col. Waring finds that about 1,200,000 square feet of side-walk were laid in the city of New York in 1895, which, with an average underlaying of ashes (four inches), would require about 15,000 cubic yards. Ashes are also used as a substratum for cellar floors; and, if the year 1895 be taken as a standard year in building, it is estimated that about 200,000 cubic yards are needed for this purpose. Similarly, it is computed that 600,000 cubic yards would be needed in the construction of fire-proof floors.

It is thus seen that the present demand for clean ashes would absorb a notable part of the actual product. These ashes have hitherto been chiefly obtained from manufacturing establishments using steam power, the demand having been greater than the supply, so that substitutes, such

as gravel, etc., have been used. Ashes appear to fill in a high degree the requirements for a loose, dry substratum on which stone or cement for walks, etc., ought to be laid, and contain enough interstitial space for the expansion of moisture in freezing, without upheaval. A further use in the manufacture of brick and concrete appears possible. On this point Col. Waring says:

"Quite lately, and during the collection of data for this paper, I have found in experimental operation, by the use of a cement whose constitution was kept a business secret, a process for making from ordinary house ashes either concrete, or stone in mass, or brick, in appearance at once pleasing to the eye and suggestive of considerable strength and toughness.

"For the purpose of determining the suitability of this material for building purposes, I had tests of its strength under compression made on the Emery Testing Machine, under direction of Prof. Ira H. Woolson, of the School of Mines, Columbia College. All pieces tested were approximately two-inch cubes; some moulded to that size, some cut from the interior of large bricks; all said to be less than thirty days old, and made without pressure; all having specific gravity about 1.78, that of ordinary brick being 1.8 to 2.0."

Specimens of these mixtures in various proportions, none of them more than thirty days old, have shown, under test, a resistance to crushing of from 5,000 to 10,000 pounds per square inch. But under the weather test these bricks utterly failed. The material appeared to do well under fire test, but this test was not carried out to definite conclusions.

The possible use of ashes for bricks, etc., therefore remains problematical. To give these bricks the proper weathering quality appears to be the principal desideratum yet to be attained in their manufacture.

Danger to Health from Unclean Streets.

IN line with what was said by Mr. Post, the eminent architect, at a recent meeting of the American Institute of Architects (see review in our architectural department, July number), is an article in the *New York Medical Journal*, which gives a plain statement of the danger that may lurk in dark and uncleaned streets and alleys.

This article, of which a brief abstract follows, asserts that we know, beyond all question, that certain disease-producing bacteria live and flourish in filth. Of these, one of the most fatal, which for obvious reasons is almost universally present in street dirt, is the germ of tuberculosis,—the cause of pulmonary consumption.

The researches of Dr. Prudden have shown that the dirt of streets, even when, as dust, it is blown high into the air, is full of bacteria. In cities we breathe air more or less charged with pulverized horse-droppings and other filth, intermingled with the bacteria named and those of other kinds; and our clothing becomes more or less saturated with this unwholesome mixture. The "*more*" or "*less*" depends upon the thoroughness—or want of it—in cleaning the streets and exposing them to solar light. "The fact that in hot weather, when the windows are open, the filth makes itself a portion of our meals, which, though not mentioned in the bill of fare, is served with more or less profusion *gratis* with every portion of food, is an additional reason for objecting to dirty streets; and our objections become stronger when we think how often, at all seasons of the year, it must contaminate the milk supplied to little children and invalids.

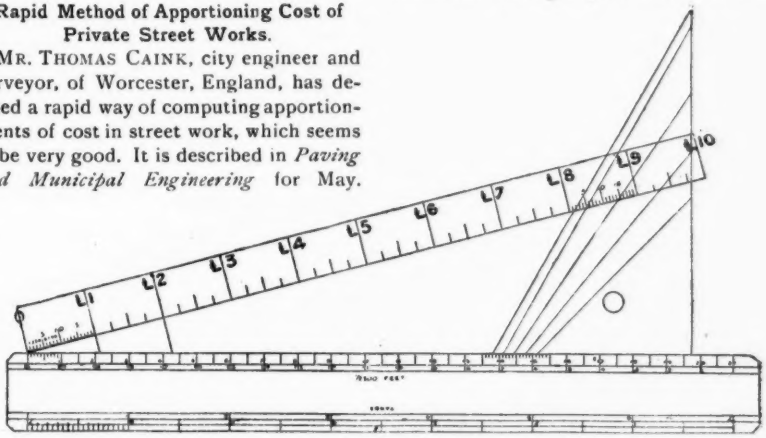
"It is not infrequently asserted that we have no absolute proof that, as a matter of fact, disease is caused by city dirt. This is quite true, but can any sane man deny that there are strong reasons for believing that disease is produced by pathogenic bacteria contained in this dirt? We know that the bacillus tuberculosis is capable of distribution with dust, and it is quite possible that the same is true of a number of other disease germs. Whether or not pathogenic bacteria are thus distributed, no one can deny that such dust is injurious to the respiratory organs, and it

must be remembered that upon any one who asserts that the introduction of filth such as this into the body is harmless rests the burden of proof of his assertion quite as much as it would had he stated that it was harmful."

The article closes with the expression of a belief that the death-rate of New York city, which is higher than it ought to be has been increased by the imperfect cleaning of streets prior to the present administration of the street-cleaning department.

Rapid Method of Apportioning Cost of Private Street Works.

MR. THOMAS CAINK, city engineer and surveyor, of Worcester, England, has devised a rapid way of computing apportionments of cost in street work, which seems to be very good. It is described in *Paving and Municipal Engineering* for May. Leaving out much that is said of the origin of the device and its economies, we reproduce the engraving illustrating it, and the description of its use.



RAPID METHOD OF APPORTIONING COST.

"As the instrument can be made by any draughtsman, the author thinks there may be town surveyors who, desirous of reducing the time of the office expended in this work, may welcome such a device. It consists of a sheet of good card-board about thirty inches long by fifteen inches wide, on which is drawn a scale of £. *s. d.* (which can be changed to dollars and cents), several ordinary scales of different degrees of openness, and a rather large set square, the transparent kind being preferable.

"The other scales (which are of boxwood) are four in number, thirty inches in length, divided with a different scale on each edge, making eight scales in all. They are as follows: 1-500th yards, 1-500th feet, 1-2,500th yards, 1-2,500th feet, two chains to an inch, with corresponding feet on opposite edge, and one chain to an inch, with corresponding feet.

"There is no need for so many scales, but these were selected as being of general usefulness, and at the same time as giving ample range to meet every case.

"The manner of using the scales is as follows: having ascertained the total cost of the work and the total length of the numerous frontages (which is most conveniently measured in yards and decimals), it is manifest that, if a scale of length can be found on which, when laid along the money scale, the total length of frontage coincides with the total cost of the work of the scale of £. *s. d.*, then every other length will coincide with the cost of that length, and the sum due in respect of each of the various frontages can be read off directly from the scales. This is the simplest case that can happen, but one which hardly ever occurs.

"A scale, however, can be selected out of those mentioned on which the total frontage will *approximate* to the total cost. Having found such a scale, place its zero point upon that of the money scale, and lay a set square against the edge of the former (as shown in sketch) in such a position that one of its angles or corners touches the ascertained total length; then

place the scales at such angle with the £. *s. d.* ($ c.) scale (by moving it to and fro upon the zero point at a pivot) that the edge of the set square just cuts the total cost upon the money scale. The two scales are then retained in position by two or three lead weights. The cost of the work in respect of the various frontages is then ascertained by sliding the set square along the edge of the boxwood scale and setting the angle at the points thereon corresponding to the lengths of the various frontages. It will be found that the edge of the set square cuts the money scale at sums proportional to the various lengths.

"In practice it will be found that the total cost and frontage usually exceed the length of the scales. In such cases it is only necessary to divide cost and length by such a common number as will bring the quotient within the range of the scales, and treat the quotients as though they were totals.

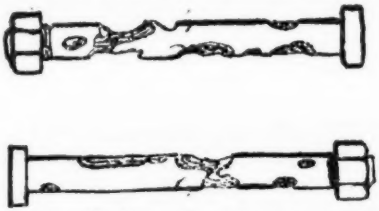
"It is important that the corners of the set square be set sharp, so as fairly to touch the wood scale. It is better, however, to use a transparent set square and scribe a line across it on the under side; a number of lines at various angles will be found convenient, being careful, however, to observe the same line throughout the same apportionment. The scribed line removes any difficulty in accurately placing the set square to the point on the scale of length which may arise in course of time from the rounding of the corners of the set square."

By using a magnifying-glass great accuracy can be obtained by the above method, while the time occupied in making an apportionment is only a small fraction of that necessitated by calculation. Mr. Caink says he has used this method for five or six years, and finds it very useful.

Corrosion of Iron by Raw Gas Tar.

THE employment of gas tar as a protection for iron surfaces is extensive; yet some facts recently brought to light show that, unless caution be exercised, tar so used may become a more active agent for destruction than the agents which it is intended to guard against.

Mr. F. J. R. Carula, at the April meeting of the Nottingham (England) section of the Society of Chemical Industry, presented an example of the action of gas tar upon iron, which is herewith reproduced from *The Gas World* (June 27), which obtained it from the journal of the society. The cut shows the appearance of two bolts, each twelve inches long and one and one-eighth inches thick. These bolts were used in a valve box as stops for the prevention of excessive rise of circular india rubber valves, and were, while in use, constantly immersed in water. The corrosion indicated in the cut is attributed to tar residues that percolated from the surface of the ground into the water wherein the bolts were immersed, and a chemical examination of the water showed that it contained free ammonia, albuminoid am-



monia, chlorids, and carbonates, which could not otherwise be accounted for.

That this corrosive action is due to something communicated by the tar would also appear to be indicated by the fact that similar bolts in a pump at the same works used for raising tar, and that only, also show corrosion of a similar character, although not quite so pronounced. The bolts in another pump, lifting river-water in the same place, show no signs of corrosion, which goes some way to indicate the common origin of the damage in the two other cases.

From a consideration of the analysis of the water, given above, one may reasonably suspect that the presence of ammonium chlorid, a considerable constituent of some gas liquors, and which, therefore, must be frequently present in crude tar, may contribute to the corrosive properties of this water.

The remarkable character of the corrosion, localized, and leaving much of the

surface almost untouched, suggests the formation of galvanic couples at a number of points, in the neighborhood of which the whole of the action has taken place. The oxid of iron that is sometimes present in wrought iron, in the form of slag left between the laminæ of which such iron is composed, may account for this peculiarity. Whatever the exact explanation may be, the examples certainly impress the necessity for neutralizing the cause of corrosion before using crude tar as a protection for iron surfaces.

The Journal of the Iron and Steel Institute, in 1892, stated, in a note derived from a German source, that raw tar ought to be heated with from two to three per cent. of lime to fit it for use as a protective coating for iron, thus neutralizing its free carbolic acid. While the action of this acid is destructive to iron, it is a preservative of wood. A structure composed partly of wood and partly of iron should have the wood parts painted with raw tar. But the analysis of the water from which the bolts shown in the cut were taken does not indicate the presence of carbolic acid. Instances are also mentioned of gasholders that have been damaged by the use of raw tar as a protective coating.

THE condition of the river at Cambridge, England, is to be improved. The town is being sewered on the separate system, and in the future rain water only will be carried to the river. The governing bodies of Trinity College and Trinity Hall have instructed Mr. Chas. E. Gritton, A.M.I.C.E., Westminster, to prepare plans.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*6523. A Suggested Remedy for a Source of Error in Official Photometry. Lewis T. Wright (The question of varying temperature as affecting not only the measurement of volume but also photometric tests, is discussed in this article which proposes a nominal standard of rate of consumption as a remedy for these inaccuracies). Jour Gas Lgt-June 2. 2000 w.

*6739. Inaugural Address of William Reginald Chester at the Meeting of the Incorporated Gas Institute (An extremely able survey of the past, present, and future of the gas industry, in which the cost of production is compared with that of electric lighting, both arts being considered in the light of the most recent advances in each). Gas Wld-June 13. 10700 w.

*6740. New Details in Gasholder Construction. E. Lloyd Pease (Short illustrated descriptions of details met with in the construction of modern gas-holders, in which some important matters are practically dealt with. Discussion). Gas Wld-June 13. 11000 w.

*6741. Gas Engines as Economical Motors. J. Holliday (Principally a comparison of different systems, with four tables of data, and discussion). Gas Wld-June 13. 6800 w.

*6742. Explosive Mixtures of Combustible Gases. Frank Clowes (Methods for detecting and measuring minute and dangerous proportions of such gases). Gas Wld-June 13. 4000 w.

*6743. Letting Gas Apparatus on Hire. Norton H. Humphrys (An exposition of a plan becoming more and more common in England. Faults pointed out and suggestions of remedies). Gas Wld-June 13. 3000 w.

*6744. The Popularization of Gas. A. Dougall (The coin-meter system is the principal topic, but the general supply of gas and hire of fittings are also treated, and a form of agreement for such service is presented). Gas Wld-June 13. 8400 w.

*6745. A Standard Photometer. W. J. Dibdin (A form of photometer suitable for adoption as a standard). Gas Wld-June 13. 2200 w.

*6746. Photometers and Standards of Light. W. Sugg (A broad treatment of the subject pointing out defects in instruments and methods, and a résumé of the history of photometry, with numerous illustrations. Discussion includes Mr. Dibdin's paper on the same subject). Gas Wld-June 13. 10000 w.

*6747. A Season's Experience with Incandescent Public Lighting. Frederick G. Dexter (Recent and extensive experience with the Welsbach light in street illumination in Winchester, Eng. Results highly favorable. Discussion). Gas Wld-June 13. 6200 w.

6893. Welsbach Street Lighting. Frederick P. Morrill (The obstacles encountered and the extent to which they have been surmounted). Pro Age-July 1. 2700 w.

Sewerage.

6556. The Bristol, Conn., Sewage-Disposal Works (Brief description with plan. The system comprises both intermittent filtration and broad irrigation). Eng Rec-June 13. 400 w.

6557. The Sewerage of Victoria, B. C. (Abstract of a paper by Edward Mohun, read before the Canadian Soc. of Civ. Engs. Descrip-

We supply copies of these articles. See introductory.

tion of details). Eng Rec–June 13. 1500 w.

6789. The Vassar College Sewage-Disposal Plant (Illustrated, detailed description). Eng Rec–June 27. 2400 w.

Streets and Pavements.

†6655. Impact and Abrasion Tests of Paving Brick. H. J. Burt (Method of carrying out tests of this kind in the Laboratory of Applied Mechanics, University of Illinois). Tech–May, '96. 2300 w.

†6656. Street Improvements at the University of Illinois. John C. Quade (Illustrated description of work done in improving the grounds of the institution). Tech–May, '96. 1000 w.

6769. Hitch Your Wagon to a Star (Editorial remarks on the street cleaners' parade and the work of that department, with remarks on other subjects of municipal interest). Gar & For–June 24. 1200 w.

6896. Work of the Street Department of Boston, Mass., in 1895 (Methods of the department; settling the lines dividing the districts; principal features of the work are summarized; copy of regulations and instructions issued; personnel of the officials of the force). Eng Rec–July 4. 2000 w.

Water Supply.

*6505. Filtration of Municipal Water-Supplies. Ill. Rudolph Hering (A comparison of rapid filtration with slow, and of continuous filtration with intermittent, accompanied by descriptions of the plants at Hamburg and Lawrence). Eng Mag–July. 4200 w.

6536. Asphalt Lining for Water-Works Reservoirs. L. J. Le Conte (Abstract of a paper read at the annual convention of the American Water Works Assn. Account of experiences with asphalt on the Pacific coast for the purpose named). Eng News–June 11. 2800 w.

6558. The Water Supply of Buenos Ayres (Translated and condensed from a memoir of D. E. R. Coni in the *Geni Sanitaire*. Illustrated description). Eng Rec–June 13. 1300 w.

†6648. Chemical Survey of the Water Supplies of Illinois. Arthur W. Palmer (Account of a series of recent examinations of the water supplies of the state of Illinois, carried out at the University of Illinois; and of an effort to arrive at a standard of purity for well waters). Tech–May, '96. 800 w.

†6649. Inspection of Water-Pipe Laying. Ralph P. Brower (Explanation of methods useful to inexperienced men). Tech–May, '96. 2000 w.

6710. The Nashua Aqueduct (Illustrated description). Eng Rec–June 20. 700 w.

6711. The Financial Management of Water-Works (Abstract of paper by Freeman C. Coffin, read before the New England Water-Works Assn. The purpose of the paper is to answer some important questions relating to receipts and expenditures, and the self-supporting or non-self-supporting character of municipal water-works systems). Eng Rec–June 20. 2500 w.

6788. The Construction of the Lower Otay Dam (Illustrated description of constructive work, interesting on account of its size and the unusual structural features). Eng Rec–June 27. 3500 w.

*6863. Why Water Meters Should Be Used (Abstract from report of engineer commission on water supply for Cincinnati. The same rules that apply to gas distribution should, the author believes, be applied to water distribution. Consumers should pay for the water they waste as well as for what they actually use). Pav & Mun Eng–July. 500 w.

6871. Sand Filter Beds for the Water-Works of Lambertville, N. J. Churchill Hungerford (Illustrated description). Eng News–July 2. 1400 w.

Miscellany.

6540. Raising Crops on Sewage Filter Beds (Experience at Pullman, Ill., at Berlin, Ont., and at South Framingham, Mass). Eng News–June 11. 1500 w.

6635. Testing of Brick and Cement (Description of the City Testing Works of St. Louis, Mo. They are said to be the most complete in the country, and test carefully all stone, brick and cement used in street paving). Clay Rec–June 15. 1700 w.

6709. Garbage Cremation Experiments in Germany (Condensed translations of three progress reports sent to Mr. Rudolph Hering from professional engineers in Germany. An exceedingly valuable and suggestive contribution to the literature of garbage cremation). Eng Rec–June 20. 4500 w.

†6756. The Introduction of Public Rain Baths in America. Harvey E. Fisk (Historical sketch. Difficulties met with and overcome by the promoter of this system. Illustrated description of these baths, and a statement of their sanitary advantages and the economy of the system). San–June. 7500 w.

*6862. Efficiency, Economy and Ethics in Municipal Engineering. Charles Carroll Brown (Faults in corporate action which result in disagreeable and expensive consequences, and their avoidance). Pav & Mun Eng–July. 1800 w.

6873. Garbage Disposal in England. James H. Fuertes (Abstract of a paper by Dr. J. Spottiswoode Cameron, published in *British Medical Journal*, with other information compiled and prepared by the writer). Eng News–July 2. 2200 w.

6891. General Street Lighting. Walton Clark (The relation of street lighting to public health, safety, and morals is dwelt upon at some length and is followed by a general consideration of the problem of street lighting, with discussion). Pro Age–July 1. 3000 w.

6971. Garbage Disposal at Tacoma and Seattle. A. McL. Hawks (Illustrated description). Eng News–July 9. 1400 w.

6975. A Hydraulic Shield for Shallow Tunnels (An illustrated description of a shield designed especially for tunneling under city streets at small depths. It has been in successful operation for some months in constructing an outlet sewer in Paris, France. It is semi-circular in shape). Eng News–July 9. 1100 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering

The Question of Track.

THE ENGINEER (London) of June 5 devotes considerable space to a discussion of permanent way, and, in the course of a two column editorial, develops a very comfortable satisfaction from the thoroughly expected conclusion that the English way is the best,—that the normal road (as it terms the bull-headed rail with chairs on widely-spaced sleepers) is "a survival of the fittest."

Not, it generously adds, "necessarily a survival of the best, but only of that best adapted to the conditions of British railway life."

The great differences in type and weight of rolling-stock might naturally involve corresponding differences in the permanent way, best adapted to each respectively; but it is hard to discover from *The Engineer* just where is this most admirable adaptation of English construction to local conditions.

The article apparently admits, as just criticisms, the statements that the maintenance of English track is costly, its surface rough, and the chairs bad for the rolling stock. Surely none of these things can be considered desirable, even in "British railway life." The treatment of derailments is neither satisfactory or reasonable, for the recent severe English accidents from this cause are attributed wholly to defective ballasting, while a general and unsupported assertion that in the United States such accidents are very common and very fatal is so made as to convey the impression that these accidents here are wholly due to the form of the flanged rail.

Even the bugbears of a dead past are unburied, and their specters paraded for fearful effect; we are assured that the flange rail has a constant overmastering desire to "turn over on its outer edge under the bursting stresses set up by the engines." Furthermore, "it eats its way into the sleepers, draws the inside spikes, becomes loose, and gives — especially on curves—an inordinate amount of trouble."

And yet the English rail, which, of course, does none of these desperate things, is admitted to be costly in maintenance: surely, here is a mystery.

Finally, it will quite surprise some of our railway men to learn that "in the United States sleepers are mostly of oak or hard wood," and that "the flange rail on a cross-sleeper road can only be a success when the sleeper is made of hard wood."

The statement that the bull-headed rail is far stiffer than the flange rail of the same weight will hardly pass unquestioned; and it is more than likely that the extra cost said to attach to the flange form of section is due to special conditions of supply and demand in the English mills.

The one argument of force is the cost of the larger amount of wood used in the American form of track. In England, where ties must be imported, this would be an important consideration; but the argument at its best could only excuse a bad practice on account of expediency; it could not establish it as a good one. It is strange, too, that this consideration of expense should seem to *The Engineer* so weighty when the purchase of ties is in question, and so unimportant when it lightly dismisses the heavy maintenance cost of English roads, or when it urges heavy stone-ballasting from end to end of every line.

As a matter of fact, it is highly probable that the "normal road" is so dear to the English heart, not because it is fittest, but because it was first; the English disposition abhors change. The original reason for its adoption was the supposition that the bull-headed rail could be turned over when one head was worn, and so present a new track surface without buying new steel. This has long been abandoned as impracticable, but the bull-headed rail obstinately survives.

The Engineer considers that "the arguments in favor of the American as compared with the English road are more matters of opinion than of fact, so far"; no doubt opinion does largely sway many debaters on both sides, but there are matters of well-established fact which have an important bearing on the question. One of these is that the perfect track must avoid extremes, either of rigidity or flexibility; the English form of construction, with heavy firmly-fixed chairs, at comparatively wide intervals, seems to err in both directions, being too rigid at the points of support, and too flexible between them. The rapid alternation of conditions as the wheel passes over spaces and chairs can not be good either for the track or the machinery supporting the moving load. The tendency is to "pump" the ties in the ballast, with probably more expensive wear and destruction and more dangerous loosening of the entire track than could result from the slight creeping of the flange-rail under the hook-headed spike.

The American practice certainly seems closer to the ideal blending of firmness and elasticity, and keeps the wear due to vertical undulation nearer to the surface. If more costly as to ties, it is cheaper as to ballast.

It is significant that the agitation for change is confined almost entirely to the other side. *The Engineer* finds among its many well-qualified correspondents "a drift of opinion in favor of a return to the old-fashioned flat footed rail spiked to cross-sleepers." We have no such important dissentient party in our country. As long as Mr. Benjamin Reece is with us—and may that be long!—the tie-plate will have its earnest advocate, but the tie-plate is an essentially different device from the rail-chair.

Our English contemporary argues itself into a very contented frame of mind with things as they are, and sees no probability of any "radical changes of any kind." It is, however, more than possible that, under the impetus of increasing speeds and weights of rolling-stock to be moved, and increasing demand by passengers for greater comfort, the 'drift of opinion" which it now notes will set into a steady current, upon which an adapted form of the American plan will be carried into Great Britain.

Light Railways and Electric Roads.

AN American reader of British and continental exchanges can hardly fail to be impressed with the amount of space devoted to the discussion of light railways, and the possible importance of the subject in the United States.

Properly used, the term designates a comparatively short feeder line, usually, though not by any means always, of narrow gage; necessarily of cheap construction; adapted only for light rolling stock and loads approximating four tons per axle; intended to tap agricultural or mining districts lying back from the main line, and to replace wagon-hauling in bringing down freight or passengers to the stations.

If such a line be wisely located, it seems to promise valuable returns to the promoters, who would receive the returns for moving the traffic formerly carried at much greater expense by wagon; to the residents and shippers of the region, who would find the new mode of transportation a gain both in convenience and economy; and to the main railroad, which would certainly receive an increased business from the greater advantages afforded for the moving of mine and farm products.

In practice the results have been widely variable, and the diverse experience gained in different localities is reflected in the wide diversity of attitude toward these enterprises displayed by different writers.

A very valuable collection of data and statistics is contained in Mr. J. W. Mackay's "Light Railways for the United Kingdom, India, and the Colonies," which is reviewed by *The Builder* (London). Mr. Mackay finds the system so successful on the continent (notably in Belgium, Hungary, Prussia, and France), in South America, and in India, that he is inclined to advocate strongly its expansion in England; but the reviewer in *The Builder* dissents from this position, basing his unfavorable judgment upon the poor average

returns of existing lines and the unpropitious conditions which, according to his view, exist generally throughout England.

It is the recital of these adverse conditions which suggests the contrast afforded by those existing in our country. Says *The Builder:* "The study of the railway map of England shows how very few towns, or indeed villages, now remain which are as much as eight miles from a station; and, even where these occur, they are situated for the most part in non-agricultural districts.

"Thus, for the most part, any new light railway which can be proposed is so cramped and hemmed round by existing main lines that its area of usefulness is curtailed to an extent that prevents any individual line from being more than ten or twelve miles in length.

"Of this already too short a distance, the first two or three miles can not be regarded as augmenting the goods traffic or helping the farmer, as he will prefer for economical reasons, to cart his goods direct to the main line." Of course, the natural effect is the curtailment of the possible business below the limit which will support an independent staff of officers, pay the running expenses, and leave any margin for dividends.

Furthermore, the reviewer finds in the hundreds of horse-drawn wagons which nightly deliver their loads of garden produce to London markets, from distances as great as twenty to twenty-five miles, an eloquent object-lesson on the subject of railway rates and transfer.

Lastly is urged the impossibility of cheap construction, owing largely to the high cost of land.

These very objections suggest the antithesis to be found in American conditions. Our land of magnificent distances affords many areas still remote enough from main lines of railway to make haulage burdensome and almost prohibitory; our wagon-roads, often execrable, are seldom so good that a twenty to twenty-five mile haul in competition with movement by rail is practicable; railway rates considered remunerative here are far below English figures, and land generally has not attained so high values as on the other side.

Yet, unless a few mining and lumber roads be considered as embodying a similar idea, the light railway has received little attention in the United States.

For passenger traffic, it is true, "the trolley" is rapidly pushing its way into prominence; but, to anyone familiar with the situation of vast numbers of agricultural communities in the middle west, it seems really extraordinary that so inferior and expensive haulage facilities have been so long tolerated, and that at least the extension of electric traction to freight movement is so tardy and so sporadic in its appearance.

An inordinate amount of attention has been attracted to the electric road as a rival or supplanter of the steam railroad; little has been said of its more probable and natural functions as an auxiliary and a feeder. The Lake Shore road is said to have discovered already that suburban electric lines, at first injurious to their traffic, soon induced a large increase therein.

Why would not the same conditions be developed even more strongly and advantageously in freight traffic, when the managers of electric lines realize their opportunity and develop from them the American light railway?

Antiquated Yard Management.

AN important, but apparently badly neglected, field for improved railway methods is briefly suggested by Mr. D. S. Sutherland in a recent contribution to the *Railway Review*,—the handling of freight trains at terminal points and in yards.

The wonderful advance which has swept along the main line, transforming almost every detail of way, equipment, and service to conform to standards scarcely dreamed of fifteen years ago, has apparently left the side tracks almost untouched. To quote Mr. Sutherland: "Freight trains are rushed over hundreds of miles of road only to be delayed in terminal yards or at interchange points. It takes longer on most railroads to get a car from the warehouse to the point where it is to be made up in a train ready to start on its journey

than it does to run the train a hundred miles; and then at the terminal it takes still longer to get it to the warehouse or connecting line."

"A great deal is said about our great double- and four-track railroads, but I hold that a good single-track railroad, with properly-equipped yards and warehouses, is capable of better results than one with any number of main tracks and poorly-equipped terminals.

"My idea of a railroad is one that has warehouses where freight can be taken from the consignor and loaded into cars, or taken from cars and delivered to consignee, with the minimum amount of handling and the least loss of time; and one that has yards where cars can be properly drilled out and grouped together at one point, and thus save switching at other points,—yards where the first cars to arrive are the first cars to leave. With very few exceptions, railroads are doing their switching the same as it was done when steam railroads first came into existence, and it costs these roads more to get a car through their yards than over any one hundred miles of their line.

"In the first place, a train arriving pulls in and occupies a track in the distributing yard, and, if several trains are in company, a track is occupied by each one, and no switching can be done until the whole fleet has arrived, and is gotten out of the way, and the chances are that then this yard is blocked, so as to render switching to any advantage almost impossible. A switch engine takes hold of the train, and the first move is to pull the train back out of the yard, and, for every cut that is made, the whole or greater portion of the train must be handled, with the result that draw bars are pulled out or broken and cars receive much more damage than they will receive on a trip over the whole line.

"Railway companies have come to realize that, in order to meet competition, it is necessary to reduce grades, increase the capacity of engines and cars, and in every way possible reduce the cost of transportation; but they do not as yet seem to realize that, in order to make this a success, it is necessary to equip their stations and terminals so as to meet the improvements in other quarters. If the capacity of freight engines is increased, it is just as necessary that the capacity of the yard be increased in proportion.

"I know of no place where there is such a chance for reduction of cost of handling as at terminals. In order to accomplish this, yards need not necessarily cover any larger territory, but they can be so laid out that the switching can be done properly and thoroughly, without loss of time or waste of power, and thereby a large reduction in cost and far better results may be arrived at. What is true of yards is also true of warehouses, meeting and passing tracks, and all other transportation facilities."

Mr. Sutherland's paper perhaps conveys too scanty a recognition of the reforms already inaugurated in laying out and managing yards; but that very much still remains to be done is only too keenly apparent to shippers and consignors,—perhaps even more to them than to railroad men.

Blank Drivers on Locomotives.

A RATHER remarkably complete abandonment of ideas once firmly fixed and unhesitatingly accepted is evidenced by the discussion following the reading, before the New York Railroad Club, of Mr. Molineux's paper on the use of blank drivers on locomotives.

It was formerly almost, if not quite, the universal practice, when an engine had more than two pairs of drivers, to have one or more with blank tires; sometimes even the eight-wheel engine had one pair of drivers blank; and yet, as Mr. Molineux says, such importance is attached to the integrity and perfection of tires in every other situation that the burden of proof should be upon those who advocate the omission rather than upon those who plead for the retention of the tire.

"The supposed advantages of blank drivers," he says, "so far as I have been able to learn them, are less strain on the track in passing around curves, the avoidance of flange friction on curves as to the

pair of blank drivers, and less strain on the engine generally."

As to the first count, however, he finds the evidence of roads using all flanged drivers to be that engines so built are no harder on the track than those with one pair blank.

As to the second, the avoidance of flange friction on the blank drivers is naturally conceded, but the argument made that the tendency of the engine to travel off at a tangent is in no wise reduced, and the work of resisting it is simply increased for the remaining flanges. The third and last count is distinctly negatived by the fact that "the riding qualities of an engine are certainly improved by using all flanged drivers."

Mr. Molineux shows that there is really no danger of the track being too tight, as an engine with a 16-foot wheel base standing on a 20-degree curve would still have (on account of the ordinary widening of gage for such a curve) a clearance of ¼ inch, as against ⅜ inch on a tangent, without allowing anything for side-play allowed in building the engine.

On the other hand, the argument for the all flanged construction is supported by many excellent claims. Practice shows that it results in fewer derailments; a crippled engine can be more readily replaced on the rails and taken to the shop in a crippled condition; the flanged tire is stronger than the blank, as well as cheaper; the engine will make more mileage with fewer sharp flanges; a smaller stock of duplicate parts is required, and more tractive power is secured because the flange keeps the effective portion of the tire more truly on the rail. And, not least, the greater confidence inspired in the enginemen results in better running and a closer adherence to time. All of these contentions Mr. Molineux supports with effective concrete instances.

The blank tire proved to have its adherents still,—some of them strong and important ones. The Pennsylvania Company practice is to have blind tires on the second and third pairs of drivers on their consolidation locomotives, and they seem well satisfied with it; but the majority was strongly with Mr. Molineux. As Mr. Sinclair remarked, the subject comes up about every second year in the Master Mechanics' Association, "and it is remarkable to find how gradually all the members have been changing in favor of flanged tires."

The Traveling Engineers' Association.

THE spirit of association, to which Mr. Ingalls refers with strong commendation in the July number of THE ENGINEERING MAGAZINE, seems to pervade most happily the entire railroad organization, with resultant general benefits whose extent could hardly be measured.

The notion that another's loss must be our gain, once an axiom of statesmanship, is rapidly dying out as a directing influence in national and commercial affairs, but nowhere has it disappeared more completely than in the railroad world, especially in the operating and mechanical departments. Officials of every rank realize that they can gain from others in intercourse immeasurably more than they give, and that a good thing is none the worse for being imparted to those who can appreciate it and return it, enlarged and improved, to its originator.

One of the most commendable of these friendly and profitable organizations is The Travelling Engineers' Association, which, though it is approaching the completion of its fourth year only, has abundantly established its value, not only to its members, but to the railroad service generally, and has won the hearty recognition of officials throughout the country.

It began Nov. 13, 1892, with a concerted meeting of fourteen traveling engineers, or road foremen of engines, who came together for the purpose of considering the possibility and advantages of a permanent organization. The outlook seemed favorable, and the first regular meeting took place in New York on January 9, 1893, organization being then effected, constitution and by-laws adopted, and the subjects assigned for discussion at the first annual meeting, which was held in Chicago.

From an original membership of 53, the roll has increased to 180, representing

about one hundred of the most important American, Canadian, and Mexican lines. The active membership is composed of practical men, who have grown up from the ranks, the eligible classes being travelling engineers or those who have advanced from that rank to a higher one, experts in air-brake practice, general foremen, and round-house foremen who have been locomotive engineers. All whose knowledge of locomotive management may be of service and value to the association are eligible as associate members.

The object and aim of the association is "the improvement of the locomotive-engine service of American railways through the advancement of knowledge concerning the duties of traveling engineers, by discussions in common and exchange of information on subjects interesting to its members, thereby making the work in all branches more systematic and efficient for members and more profitable to the railroads."

The subjects discussed by the association have been noteworthy for their lively interest and close relation to the practical and economical service of our railways; many of them are among the most important now being considered in the railway world.

The next annual meeting will be held at Minneapolis on September 8. Some of the topics proposed are: "Could not the locomotive service of the country be improved, if the furnishing of feed-water and coal were in the hands of the locomotive department?" "Would the rating of engine loads by tons instead of by cars decrease train delays and increase the efficiency of the power, and what is the best method of equalizing the difference between empties and loads?" "Standard forms of examination of firemen for promotion and of new men for employment," and "The proper operation and care of and instructions concerning sight-feed lubricators."

The circulars of inquiry issued by the committees in charge of the various topics display the breadth and thoroughness with which the discussions are undertaken. The association certainly seems destined to wield an excellent influence, and merits the cordial approval and coöperation of the higher officials.

ALTHOUGH we in this country are supposed by our English cousins to be hopelessly joined to our railway idols, we must admit that the English railways show a consideration for the convenience of special patrons which might well be recommended to our passenger department, the I. S. C. Law permitting. One of these, to quote *The Engineer*, is "an arrangement for special tickets for members of golf clubs"; another is "the issue of week-end return tickets, at about single fare, for the use of commercial travelers" returning home to spend Sunday. A third, recently mentioned, is a return ticket good going from A to B and returning from C to A, the distance from B to C being over some scenic district tempting to bicyclists. Such a recognition of healthy amusements is good both ethically and financially.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*6504. The Turning Point in Railway Reforms. M. E. Ingalls (Showing that rate-agreements and the abolition of rate-cutting mark a new era in railroading). Eng Mag-July. 2700 w.

*6513. The Great Western Railway Company's Latest Express Engines (A descriptive account with photographs, dimensions, and some figures of performance). Ry Wld-June. 700 w.

*6514. A Belgian Light Railway (The article gives general features of construction and equipment, with map of the road and terminals and drawings of rolling-stock). Ry Wld-June. 1100 w.

*6515. Manganese Steel Points and Crossings (Recommending manganese steel for positions of heavy wear and alleging American experience in support of the practice). Ry Wld-June. 700 w.

†6516. Agabey's System of Repeating Signals between Stations and Trains in Motion (This is an adaptation of electro magnetic signalling by which the position of the home signal is shown by an indicator on the locomotive of an approaching train. It is hardly applicable to American practice). Ind Engng-May 9. 900 w.

6518. The Efficiency of Compressed Air for

We supply copies of these articles. See introductory.

Street Car Motors. Robert Lundell, with Editorial (The object of the paper is to correct erroneous impressions, and deals only with efficiency). Elec Eng–June 10. 2000 w.

6533 New Freight Cars for the Baltimore & Ohio R. R. (Gives dimensions and abstract of specifications for a large order of freight cars). Eng News–June 11. 1100 w.

6538 Urban Growth and the Electric Railway. Louis Bell (A discussion of the influence of improved street traction on the enlargement of a city. Boston is the typical instance used as an illustration. A map shows the enlarged time-radius). Eng News–June 11. 2700 w.

6541. Railroad Earnings in May (Summary and groupings of earnings and mileage for May, and for five months, with comparative figures of same periods in 1895). Bradstreet's–June 13. 800 w.

*6542. Railways in Asiatic Turkey (Reviews the present construction and future possibilities. The situation is described as peculiarly Turkish, and not very encouraging to European capital). Eng, Lond–June 5. 2300 w.

*6543. The Dalmuir and Clydebank Railway (Descriptive of construction of a short railroad presenting peculiar difficulties in the crossing of a canal and of other roads). Eng, Lond–June 5. 1300 w.

*6545. Permanent Way (Editorial review of the distinctive characteristics of American and English practice, favorable in tone to the latter). Eng, Lond–June 5. 2000 w.

6546. Economical Use of Large Freight Cars (Report of the Committee on Official Classification and Large Cars, C. H. Bieber (Mich. Central), Chairman, read at the Convention of the International Assn. of Car Accountants at Cleveland (Condensed). The striking feature is the recommendation of a radical change in the reduction of present minimum weights for many classes of freight). R R Gaz–June 12. 1200 w.

6547. 80,000-lb. Ore Car for the Erie Railroad (A very full description, condensed from specification, with dimensional and sectional drawings). R R Gaz–June 12 1400 w.

6548. The Pennsylvania Railroad Voluntary Relief Department (Gives in brief form the chief principles upon which the plan is formulated). R R Gaz–June 12. 1100 w.

6549 Emergencies in Railroad Work. L. F. Loree (Extracts from a lecture delivered before the students of the College of Mechanics and Engineering, University of Wisconsin. Treats of wrecks, washouts and strikes, and the preparations which can be made for dealing promptly with such events). R R Gaz–June 12. 3600 w.

*6550. Heating Carriages on the Eastern Railway of France (The first number reviews the crude and unsatisfactory methods still largely in vogue, and describes the Lancrenon steam-heating apparatus, and diagrams. It affords an interesting comparison with American practice). Engng–June 5. Serial. 1st part. 3000 w.

*6552. The Dublin Electric Tramway System (The first number is devoted principally to the power system, with map of the route and plan of power station). Engng–June 5. Serial. 1st part. 2500 w.

6564. The Safety Appliance Act, and Automatic Couplers (Editorial advocating a broad interpretation of the law and prompt compliance with it). Ry Mas Mech–June. 1000 w.

6565 M. C. B. Coupler Attachments (A review of the inferior design and workmanship of many devices now in use or proposed). Ry Mas Mech–June. 1100 w.

6566. The Inspection of Air Brake Hose (A plea for greater care in determining the cause of damage and failure). Ry Mas Mech–June. 1200 w.

6567 Sixty Thousand Pounds Furniture Car, Chicago, Great Western Railway (A large car carefully designed to exclude superfluous material. Partial drawings and dimensions). Ry Mas Mech–June. 1400 w.

6568. New Fast Passenger Locomotive, C. R. I. & P. Ry. (Dimensions and partial drawings with brief descriptive account). Ry Mas Mech–June. 300 w.

6569. Twenty Years of Railways. Horace R. Hobart (A review of the last two decades, with statistical tables and graphic charts of construction, mileage, financial condition, etc, with editorial). Ry Age–June 13 6200 w.

6570 Feed Water Purifying (A symposium of replies from important roads, to a circular of inquiry as to experience and methods tested). Ry Age–June 13. 6800 w.

6581. Relations Between Boilers, Cylinders and Weight on Driving Wheels of Locomotives. Maurice Demoulin (From the Bulletin of the International Railway Congress. The first number is concerned chiefly with discussion of the ratio of grate and heating surface, to adhesive weight in various typical European and American locomotives, of which data are given in tabular form. Some space is given to forced draft, fuel, and the contrasting preference for power and economy respectively in American and European practice). Ry Rev–June 13. Serial. 1st part. 2200 w.

6582. The Depew Shops—N. Y. C & H. R. R. R. (Gives a brief description of plan and equipment, with plat and exterior and interior views) Ry Rev–June 13. 1000 w.

6620. Progress in Adopting Safety Appliances in Railway Equipment. Edward E. Moseley (A statistical article showing the percentage of total equipment already fitted, and reviewing existing and pending legislation). R R Car Jour–June. 1300 w.

6621. Efficiency of Foundation Brake Gear. R. A. Parke (Criticises the defective design of freight car trucks from the point of view of brake efficiency, and advocates a higher maximum braking force, and inside hanging of brakes). R R Car Jour–June. 1200 w.

6622. Facts Going to Waste. George S. Hodgins (A plea for the collection of data by car inspection and other departments, in the interest of valuable general conclusions). R R Car Jour–June. 2500 w.

6623. Compressed Air in Car Shops. William Apps (A discussion of compresser efficiency, with table of cost per lift according to cylinder, area, and maximum weight). R R Car Jour-June. 1600 w.

6624. Art in Car Building. Duane Doty (A summary of modern practice in interior and exterior finish and decoration, based on Pullman standards and artistically illustrated with reproduction of designs). R R Car Jour-June. 3000 w.

6625. The "Black Diamond" Express (A good description of a recent typical American express train, with diagrams and photo-engravings). R R Car Jour-June. 450 w.

6626. Economical Oiling of Brake Cylinders (Report of Committee of Assn. of Railroad Air-brake Men. Urges necessity of uniform treatment on account of rapid increase of freight equipment, and discusses frequency of oiling, lubricants, methods and location of cylinders). R R Car Jour-June. 3000 w.

6627. Maintenance of Passenger and Freight Brakes (Report of committee at third annual convention of Assn. Railroad Air-brake Men. A full discussion of equipment, valves, tools, methods, reports, etc., with illustrations of apparatus and forms for records). R R Car Jour-June. 4000 w.

6628. Car Owners' Responsibility. F. H. Stark (Largely a review of the unsatisfactory results, insufficient earnings and heavy repair charges on freight cars under the present system). R R Car Jour-June. 2800 w.

6629. The Relation of the M. C. B. Rules of Interchange and the Basis or Rate of Car Hire to Facility of Car Movement. W. W. Wheatly (An exposition of the inadaptability of present basis of payment or inspection to expediting car movements). R R Car Jour-June. 2000 w.

*6630. A Universal Sanitary Street Car (A new pattern adaptable to all weathers, and possessing many novel features). St Ry Rev-June 15. 1000 w.

*6631. Fenders, Are They Practicable? M. D. Stein (A paper read before the California Street Railway Assn. The points emphasized are the unsatisfactory results from types experimented with, the alleged increase in number of accidents when fenders are used and the need of statistics). St Ry Rev-June 15. 2800 w.

*6632. New Incline up Lookout Mountain at Chattanooga (A description of the construction, operation and safety devices). St Ry Rev-June 15. 2200 w.

*6633. Duties of Passengers to Obey Company's Rules (Digest of decision sustaining the company's right to enforce reasonable rules, and reversing a verdict awarding damage to a passenger ejected for violating such a rule). St Ry Rev-June 15. 1200 w.

*6634. Testing Drop Around Rail Joints. Franklin Sheble (The object is chiefly to urge the importance of such tests and the remedying of defects indicated thereby). St Ry Rev-June 15. 1100 w.

†6645. The Construction of a Railway Tunnel at Hamilton, Ontario, Ill. Peter Mogensen (Describes in some detail the construction of a 2000-ft., double track tunnel, chiefly through loose material, with data of quantities and cost). Tech-May, '96. 3500 w.

†6659. The Railway Transition Spiral on Old Railway Curves Arthur U. Talbot (Methods of computation and field work for inserting a spiral between two curves, or between a tangent and a curve). Tech-May, '96. 1200 w.

†6660. Degree of Curve. William D. Pence (The single chord, short chord and arc definitions are discussed, differences between respective radii for all degrees tabulated, and formulæ for sub chord correction and determination of radius, and excess of arc over chord are deduced and graphically illustrated). Tech-May, '96. 1400 w.

†6669 Block Signalling (Notes on a lecture delivered by George W. Blodgett. Treats very briefly absolute and permissive blocking, running trains by telegraph and signalling in yards). Trans Assn of Civ Engs of Cornell Univ-June, '96. 1400 w.

6673. The Bridge Disaster at Victoria, B. C. (A review of the accident and the causes as deduced from expert investigation; with views of the wreck and rotten bridge members, and strain sheet). Eng News-June 18. 3000 w.

6674. Railway Yards and Terminals. W. L. Derr (A thorough and able discussion of governing principles of design and practice, track arrangement and usage, switching, electric communication, lighting, signalling, and location of yard accessories, with plan and diagrams). Eng News-June 18. 4800 w.

6675. The Construction and Operation of Railway Yards (Sums up certain general principles and calls attention to the inadequate consideration too often given the matter in the country). Eng News-June 18. 1700 w.

6676. Burnside Shops, Illinois Central R R. (The first number treats of the general plan of the shops and connected yard, sewerage, drainage, lighting, water supply and minor yard features, and also of the buildings, with dimension and construction details). Eng News-June 18. Serial. 1st part. 3500 w.

6677. Twelve-Wheel Locomotive; St. Lawrence & Adirondack Ry. (Brief description with details of dimensions). Eng News-June 18. 500 w.

6680. New Eight-Wheeled Locomotive of the Boston & Maine. (A very full description with dimension drawings of details, and indicator cards). R R Gaz-June 19. 2800 w.

6681. Comparative Efficiency of Pintsch and City Gas (Abstract of report by Mr. P. H. Brangs, Electrician of the D. L. & W. R. R., showing results extremely favorable to Pintsch). R R Gaz-June 19. 1200 w.

6682. The Master Car Builders' Convention (Abstracts of a number of reports and partial list of exhibits. Some of the important topics are metal under framing for freight cars, freight car doors and attachments, mounting wheels, stenciling of cars, handholds and height of drawbars, location of air-brake cylinders, supervision of

standards, &c). R R Gaz–June 19. 10000 w.

6683. The Work of the Brake Shoe Test Committee (Editorial review of the committee reports, with diagrams and tables). R R Gaz–June 19. 2200 w.

6684. Supreme Court on the Separate Car Law (A review of Justice Harlan's dissenting opinion. The review severely criticises the law). R R Gaz–June 19. 1100 w.

*6686. Recent Improvements in Maintenance of Way. Benjamin Reece (Considers ballast, ties, rail and fastenings from the point of view of necessity of excellence imposed by competitive struggle for business). Jour Assn of Engng Socs–May. 5000 w.

6758. The Progress of American Car Construction. H. S. Haines (Address delivered at the Master Car Builders' Convention, reviewing the rapid improvement in comfort and safety and the wide field still open to inventive genius). Ry Rev–June 20. 3200 w.

6759. Annulling Part of a Train Order. J. F. Mackie (A paper read before the National Assn. of Train Dispatchers, urging propriety and convenience of the proposed amendment of Am. Ry. Assn. rules permitting a particular movement to be superseded). Ry Age–June 20. 2000 w.

6760. The Johnson-Lundell Railway System (Describes a short surface-contact line, with description of the operation of the system, photographs and diagrams. Gives little information as to practical success). Elec Eng–June 24. 1800 w.

6762 Electric Heating. Edward Puchta (Abstract of paper read before the Chicago Elec. Assn. Deals principally with car heating). Elec Eng–June 24. 1800 w.

†6763. The East Coast Railway of India (Describes chiefly the points of importance reached by the line. The chief object is to secure the pilgrim traffic to the shrine of "Jagannath," with map). Ind Engng–May 16. 1400 w.

6764. Standard Track of American Railways (An important and valuable compilation of the standard practice of 53 chief American roads as to every important item of track construction. given both in the form of descriptive notes and in a well arranged table. With editorial). Eng News–June 25. 9700 w.

6766. Annual Convention of the Railway Master Mechanics' Association (A condensed report of the meeting at Saratoga, with short abstracts giving the conclusions of committee reports on exhaust pipes, balanced valves, reciprocating parts, cylinder bushings, hub liners, steam pipe joints, and the safety of radial stay boilers). Eng News–June 25. 2700 w.

6773. Axle and Journal Box for 80000 lb. Cars (From the M. C. B. Committee report. An extensive abstract giving formulæ for dimension calculations, discussion of stress and breakage, friction and lubrication in the journal, specifications and test). R R Gaz–June 26. 5200 w.

6774. The Tramps and the Railroads (Editorial, reviewing the danger from the tramp class, and accidents traceable to them). R R Gaz–June 26. 1000 w.

6775. May Accidents (A classified table, with comparison with the same month in the five previous years). R R Gaz–June 26. 500 w.

*6777. Express Passenger Engine, Boston and Albany Railroad (Descriptive specifications are given with indicator diagrams, sectional drawings of cylinder and valve, and comment on the peculiarities and merits of the Fay Richardson valve). Eng, Lond–June 19. 1100 w.

*6779. A New Lubricant for Railway Axles (Gives some phenomenal comparative figures from tests on the Prussian State Railways, but no hint as to the composition). Eng, Lond–June 19. 800 w.

†6781. Tool Rooms in Machine Shops (Committee report before the Western Railway Club, embodying recommendation as to selection and arrangement of tools in the room, and regulations for the issuing of tools and their use by workmen. With diagrams). Pro of Cent Ry Club–May. 1400 w.

†6782. Air-Brake Testing and Inspecting Plants (Discussion in the Western Railway Club, of committee report presented at the preceding meeting, devoted chiefly to compressors and pumps, and the time necessary for testing trains properly). Pro West Ry Club–May. 7800 w.

6783. 19 vs. 31 Train Orders. Harry B. Ware (Read before the annual convention of the Train Dispatchers' Association of America. Arguing for the use of the 19 order in place of the 31. on account of the frequent and sometimes annoying delays occasioned by the requirements of the latter). Ry Age–June 27. 1000 w.

*6787. Light Railways (Discussion of a book by J. C. Mackay on "Light Railways for the United Kingdom, India, and the Colonies." The review questions the advantages of light railways under the conditions existing in England). Builder–June 20. 2000 w.

6800. Electrical Operation of the Lake Street Elevated Road, in Chicago (Description of construction and equipment under the third rail system, with photographs of structure and drawing of third rail connections). W Elec–June 27. 1200 w.

†6814. Is It Good Practice to Use Blank Drivers on Locomotives. L. E. Molineux (Paper before N. Y. R. R. Club, strongly favoring flanges on all drivers, claiming fewer derailments, easier replacement and movement of cripples, greater strength and tractive power. more mileage and minor advantages. Discussion in accord with the paper). N Y R R Club May 21. 9400 w.

6815. Illinois Central Lake Front Improvements (An account of an important piece of improvement, with plan of the tracks before and after the alterations). Ry Rev–June 27. 1100 w

6816. The Reports of the Master Mechanics' Association (A summary of reports on exhaust pipes and steam passages, thickness of engine truck wheel flanges, cylinder bushing, and driv-

ing box wedges, with editorial). Ry Rev–June 27. 10000 w.

6848. Elmira Street Railways (Brief illustrated description of power house, line construction and equipment). Elec Wld–July 4. 2300 w.

6851. The Outlook for the Electric Railway. F. C. Armstrong (Read before the Canadian Elec. Assn. Reviews development of the past decade, discusses the suitability of the electric railway to replace the "light railways" of Europe, and the probability of electric traction being adapted to trunk railroads). Elec Rev–July 1. 1800 w.

6869. From the Mountains to the Sea (Account of a projected outlet from the central states to tide water from which great things are expected). Mfrs' Rec–July 3. 1800 w.

6870. The Salt Lake and Mercur Railroad. W. P. Hardesty (Map, photographs and description of the line and equipment). Eng News–July 2. 1600 w.

6872. The Construction of Steel Cars (Editorial on the report of the M. C. B. Association committee. The introduction of steel is considered inevitable). Eng News–July 2. 2400 w.

6875. Ohio State Law Regulating the Interlocking of Railway Grade Crossings (Text of the bill just passed, with editorial). Eng News–July 2. 900 w.

6877. The Guatemala Northern Railway (Short historical sketch, with map, profile, brief description of the line and the train service). Eng News–July 2. 500 w.

6882. A Record Run from London to Paris. J. Pearson Pattinson (The time is given in detail, the run being made in six hours and a half). R R Gaz–July 3. 800 w.

*6883. The Eastern End of the Great Siberian Railway (A summary of progress on the several divisions, with many photographs along the lines). Loc Engng–July. 350 w.

*6884. Postal Car—Erie Railroad (Description, drawings of construction and photographs showing interior arrangement) Loc Engng–July. 700 w.

*6885. About Hot Boxes (Attributes the trouble generally to rough and inferior construction). Loc Engng–July. 600 w.

*6886. A Simple Method of Testing Railroad Signal Lamps. T. A. Lawes (Reviews progress in perfecting lenses, position of flame and protection against wind, shocks and overheating, with simple tests for photometric and other qualities). Loc Engng–July. 1200 w.

*6887. New Express Engine on the Great Western Railway, England. P. J. Cowan (Dimensions and performance of a recent English express locomotive; with photograph). Loc Engng–July. 600 w.

*6888 Diversity of Rolling Stock Details (Recommending extension of standardization to smaller parts, especially of locomotives). Loc Engng–July. 900 w.

6889. A Plea for the Little Roads. C. O. Scranton (Read at the Car Accountants' convention. A review of the disadvantages imposed on small roads in the way of undue operating expenses, and especially of inadequate proportion of revenue and oppressive treatment from through lines. Recommends their encouragement as feeders). Ry Age–July 3. 2000 w.

†6902. Return Circuits of Electric Railways Charles Hewitt (The cause of electrolysis; the various devices that have been suggested for overcoming the trouble). Jour Fr Inst–July. 3000 w.

*6904. Continuous Railway Brakes (An editorial comparing the automatic vacuum and Westinghouse systems, to the advantage of the former). Engng–June 26. 800 w.

†6914. Electric Railway Construction in Germany. Louis J. Magee (A general review of German systems of finance, construction, equipment and operation). St Ry Jour–July. 5000 w.

†6915. Studies in Economic Practice. C. B. Fairchild (Describes shop methods, tools and devices of the Chicago City Railway) St Ry Jour–July. Serial. 1st part. 4000 w.

†6916. Correct Location of Trolley Wire on Special Curves Charles A. Alden (Describing a simple mechanical method with diagram). St Ry Jour–July 4000 w.

†6917 Mileage. Long Distance Riding and Transfer Systems in American Cities (A summary of the situation in thirty-eight important cities, with editorial). St Ry Jour–July. 2200 w.

†6918. Steam Piping for Electric Railway Power Plants. George H. Davis (A discussion of various methods of installation, with their comparative merits. Cuts, and a suggestion of a new system). St Ry Jour–July. 4500 w.

†6920. American Street Railway Investments (The combined operating statistics of 241 properties. The companies are divided into three groups, giving figures for four years, three years, two years and one year respectively). St Ry Jour–July. 1800 w.

6959 New York State Civil Service Examination for Electric Railroad Experts (Questions used in the examination just held). Elec Eng–July 8. 500 w.

6967. Recent Improvements in the Albany Street,-Railway Power House (Advances in engineering worthy of study). Elec Wld–July 11. 700 w.

6970. Steep Grades on Electric Railways. S. L. Foster (Extract from a paper read at the first annual meeting of the California Street Railway Assn. Chiefly a discussion of the comparative merits of running motors in series and in multiple, with a strong leaning in favor of the former). Eng News–July 9 2500 w.

6973 Railway Yards and Terminals. T. Appleton (A review of Mr. Derr's article on the subject commending his principles but questioning the practicability of his plan). Eng News–July 9. 2000 w.

6977. Prospects of Railway Construction and for Manufacturing in China (A reprint of a report by Minister Charles Denby, predicting great expansion of railroad and industrial enterprises in China). Eng News–July 9. 1000 w.

SCIENTIFIC MISCELLANY

The Wind Storm at St. Louis.

THE after-effect of this storm upon the scientific world has been to impress the truth that we know scarcely anything about the tremendous discharges of energy called tornadoes, and that their results differ materially from those of the specific category of causes hitherto assigned. Something we know of the motion of the air currents during the progress of such storms, but even this knowledge may prove surprisingly small in the light of knowledge yet to be gained. In view of the meager data we now possess, many of the effects appear altogether anomalous. An account of these by Mr. John C. Barrows, an eye-witness, with engravings from photographs taken on the spot, in *Scientific American* (June 27), shows that hitherto-entertained theories are inadequate explanations of what goes on in the central tracks of these terrific scourges. A wild, resistless energy tending to overwhelming destruction,—that, in sum, is about all we know of the character of a storm like that which devastated St. Louis.

Two apparently contradictory conditions appear to have attended the progress of the storm,—to wit, excessive unbalanced pressure upon exterior surfaces, and excessive unbalanced pressure upon the interior surfaces of buildings. Whether these conditions rapidly succeeded each other, or whether they bore a constant relation of position with the central axis of the storm, is not positively known, but there are indications that changes in these conditions were sudden; that buildings subjected to great pressure upon the outside were suddenly and unaccountably relieved of exterior pressure, thus leaving the doomed structures stuffed with air at a pressure considerably above the normal, while the exterior pressure fell below the normal atmospheric pressure. In no other way can even a plausible theory be framed to account for some of the destruction shown by these photographs. Fronts of buildings forced *out*, not in; glass windows shivered and the glass heaped *outside*, not on floors inside; roofs lifted off, and dropped at a distance; east walls and west walls, *in about equal number*, thrown down *in the same district*,—these are some of the curious features of the wrecked buildings which indicate a force acting from within toward the outside.

Mr. Barrows tries to account for these singular effects by supposing an exterior partial vacuum to have been suddenly formed. The results certainly resemble those of explosions in many instances, but they could not have occurred by reason of an exterior vacuum, unless this was almost instantaneous in character. A very short time would, in the majority of cases, permit the equalization of exterior and interior pressure, as crevices around doors and windows, chimneys, and ventilating flues would prevent the air from exerting an inside unbalanced pressure, unless the exterior partial vacuum be supposed to have formed almost instantaneously. And, if so formed, what formed it? It seems useless, until investigation reveals something now unknown of the causes which generate these intense local storms, to speculate much upon the matter. It is time that persistent scientific research were directed to the subject. It may be found that atmospheric electricity plays an important part.

In a certain area which Mr. Barrows calls the "vacuum district," the havoc was most conspicuous in buildings having few openings to the exterior.

With reference to some other phenomena, it is apparent that, if they were produced by the mere velocity of wind, our ideas of the velocity that winds may attain have hitherto been very far short of the reality. A pine board was driven through a ⅜-inch iron plate and left sticking there. One hundred miles per hour has been regarded as almost a maximum wind velocity,—in other words, a velocity

per second of about one hundred and nineteen feet. Can it be supposed that such a velocity could project a piece of soft pine through an iron plate? Such an effect might be expected with a velocity generated by a discharge of a rifle,—say, two thousand feet per second. It is plain that, if wind alone is to account for facts of this kind, we must remodel our conceptions of its maximum velocity.

That vacuum effects were produced can not be doubted. The sudden lifting of the gas tank in Gratiot street, vouched for by the superintendent of the works of which it was a part, shows that either exterior pressure was suddenly reduced, or interior pressure was suddenly increased. Perhaps both these things happened simultaneously. Nothing in the nature of the case suggests the probability of a sudden increase of pressure in the contained gas. The only alternative is the supposition that the barometric pressure upon the outside became suddenly so much less than normal as to leave the pressure of the confined gas in excess. The fact that areas of partial vacuum were generated is not doubted. It is, however, possible to conjecture that some other force, either unknown as a force, or, more probably, manifesting itself in an unknown way, is the underlying cause, not only of the great atmospheric disturbance, but also of the movements of other bodies exposed to its influence. We shall not be the first to think it not unreasonable that great discharges of repulsive force may issue from the earth's surface, although this has never yet been satisfactorily demonstrated. May not certain conditions yet undreamed of be concerned in the production of tornadoes?

Limitations of Scientific Knowledge.

"BUT, when I think how infinitely little is all that I have done, I cannot feel pride; I only see the great kindness of my scientific comrades, and of all my friends, in crediting me for so much. One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years; that word is failure. I know no more of electric and magnetic force or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students of natural philosophy fifty years ago in my first session as professor. Something of sadness must come of failure; but, in the pursuit of science, inborn necessity to make the effort brings with it much of the *certaminis gaudia*, and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work."

The above quotation from a speech of Lord Kelvin, in reply to a toast on the occasion of the recent jubilee held in honor of the fiftieth year of his professorship in Glasgow University, voices a sentiment the force of which can be appreciated only by men who, like himself, are nearing the close of life. It can be fully appreciated only by men who have devoted themselves to scientific research. Entering upon a field having no boundaries, the realization of its vastness and the utter hopelessness of the search for the ultimate grow upon them constantly, until their entire stock of knowledge seems to dwindle into a mere infinitesimal in comparison. The littleness of man, the restrictions which environ his intellect, the suspicion that there are active forces and causes yet undiscerned of which, from their very nature, he can never know anything except by inference,—these and other considerations so force themselves upon the true scientist that pride in his work is mingled with humility, as he reflects upon what he has been able to do, how much there is yet left for others to do, and how much can never be done by human effort.

The greatest scientific men have thus been simple, unassuming men. The tendency of their pursuits is to make them a class apart. The love of truth becomes almost a passion with them. Social conventionalities are false and hollow, and what is called "good form" matters little to men whose thoughts rarely descend to conventionalities. Hence in manners and dress they are apt to be somewhat peculiar, sometimes exposing themselves to personal ridicule, but, for the most part,

they are entirely oblivious to it. Any one who has seen a portrait of Lord Kelvin will agree that, without knowing the man the picture represents, one might take him for a boss mechanic. There is nothing in his plain, unaffected countenance to mark him as one of the foremost of scientists, of teachers, of investigators, of inventors, now living. He is neither distinguished-looking in face or in dress; and those who have described this great man unite in portraying his manners as simple and unaffected.

His ripe age, upon which honors have fallen like leaves in autumn, has taught him the littleness of the things which men most eagerly seek; and experience has shown him how soon the majority of mankind are forgotten when they finally depart. We may well believe him when, considering all these things, and looking forward to his own departure, he utters the significant words: "I cannot feel pride."

Probable Increase of Tobacco Culture in the United States.

AN industry in the United States that seems likely to obtain an impulse from the war in Cuba is the culture of tobacco. *The St. Louis Globe-Democrat* announces the opinion that this country has now the opportunity to become independent of foreign leaf tobacco. *Bradstreet's* (June 20) reviews the article editorially, and presents facts of interest with reference to localities where good tobacco can be grown, the quality of tobacco produced in different places, etc.

"In Pennsylvania the tobacco product is large—last year 64,500,000 pounds. It has been hinted that many excellent Havanas are not very different from the tobacco of Pennsylvania, which in its raw state has been sold for six cents per pound. The peculiarity is that it is a gummy leaf. The tobacco leaf itself is the shape and size of the rubber house-plant. It grows about four feet high and bears a slender-veined leaf. In the Keystone State this leaf has a close texture and a gumminess that unfits it for wrappers, but makes it fine filler, and, it is said, could be used for the best Cuban filler in the world without fear of detection. Since the prohibition affecting the Havana leaf, the price has gone up.

"Florida tobacco product is so fine that the most careless growers can get forty-five cents a pound for it. One trouble is that there is so very little of the crop. It grows luxuriously enough, but, with foreign competition so near them, the Florida growers do not increase the acreage. Many have refused to sort their leaves, sending them helter skelter in 'running lots,' but even in this way a very nice price is obtained. Recently a certain dealer offered one dollar per pound for all the Florida tobacco he could get.

"In Connecticut a great many farmers raise tobacco. While the Connecticut wrapper is dry and tough, it has moisture enough to keep the cigar in flavor, and does not break. It is this peculiar quality in the leaf that makes it in such demand for wrapping purposes. But it is in the flavor that the Connecticut leaf excels. There is a tobacco known as 'cimmer.' It is a very good medium tobacco. It is raised in great quantities in Ohio, Wisconsin, and Massachusetts."

The *Globe-Democrat* says that "cimmer" brings eighteen cents per pound in Ohio, but less in other States. It has not paid the farmers of Illinois to raise tobacco, though, it is said, an excellent quality can be grown there. Near Corning, New York, tobacco is cultivated, and is in quick home demand. Some tobacco is raised in Vermont, which also finds a near market. Tobacco has recently advanced notably in price, and it may be a good time for farmers who are getting very low prices for other crops to consider the advisability of turning their attention to cultivating tobacco.

Electrolysis of Hydrochloric Acid.

IN *American Chemical Journal* for July, a description of a satisfactory apparatus for effecting electrolysis of hydrochloric acid, as a laboratory and class-room experiment, is jointly contributed by Mr. Geo. O. Higley and Mr. B. J. Howard. The exhibition of equal volumes of

chlorine and hydrogen has hitherto been difficult and the apparatus employed has been complicated. The experimenters explain that the accuracy of their new apparatus in operation "depends upon the fact that the gases traverse but a small layer of liquid, while they are collected and measured in separate tubes, distinct from the ones which contain the electrodes. They can also be measured under diminished pressure by the use of a leveling-bulb attached to the stop-cock *c* (Figs. 1 and 2).

"In order to operate the apparatus, the small cups holding the electrodes are

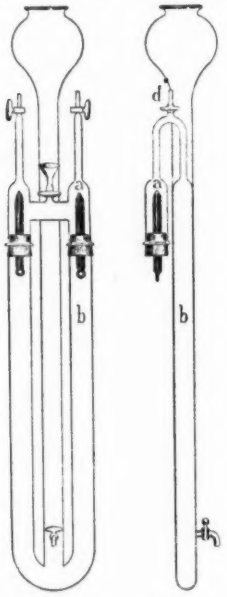


Fig. 1. Front view. Fig. 2. Side view.

filled with a solution consisting of equal parts of concentrated hydrochloric acid and water, which has been saturated with chlorine, and to which an excess of sodium chlorid has been added just previous to the experiment, the stop-cock *d* being kept open. The remainder of the apparatus is then filled with chlorine water, and, all stop-cocks being closed, the current is turned on for five or ten minutes. The apparatus is then opened, the leveling-bulb adjusted so that the liquid rises to *d*, then *d* is closed, and electrolysis carried on under increased or diminished pressure. The results in the former case are less satisfactory than in the latter. With increased pressure from 8.5 to 9.3 cc. of chlorine are collected for every 10 cc. of hydrogen, while with diminished pressure the results are very nearly in absolute accord with theory. The gases are finally measured under atmospheric pressure."

Soldering Glass.

AN item has recently appeared in a number of foreign technical publications announcing the fact of a discovery which may prove to be of industrial importance. Two different alloys, melting at not too high temperatures, have been found strongly adherent to glass surfaces. One of these is composed of ninety-five parts tin and five parts zinc, and melts at 200° C. Another, composed of ninety parts tin and ten parts aluminum, melts at 300° C. and is said to adhere to glass with great force. It is further stated that, with either of these alloys, soldering glass is as easy as soldering metals. If the glass be heated to the melting-point of the solder, with the usual precautions for preventing its cracking, a small bar of the alloy may be passed over the edges it is desired to join, and the edges, pressed together till they are cooled, will be firmly united. A wand of paper may be used to distribute the melted alloy evenly along the surfaces to be joined. Also an ordinary soldering iron may be used, as in soldering metals to metals. It is alleged that their alloys have a fine metallic luster, which, under ordinary conditions, is well retained. This being the case, it would seem that such alloys might possibly be made substitutes for the amalgam of tin and mercury used in the manufacture of looking-glasses.

The Chardonette Process for Producing Artificial Silk.

THE manufacture of an artificial silk from cellulose, invented some years ago by M. Chardonette, has been long in getting commercially started in England; but it has been one of the manufactures of France since 1893. It now appears from

a recent article in *Nature* that the demand for this article has so much increased as to encourage the establishment of the industry in Manchester by a new company operating under license from the patentee. The London *Times* recently had an article describing the process, which is an interesting one, with striking analogies to the process by which the silk-worm converts a plastic material into a continuous filament.

The pulp, thoroughly cleansed, and looking very much like thick gum, is put in cylinders, from which it is forced by pneumatic pressure into pipes passing into the spinning department. Here the machinery looks like that employed in Lancashire spinning sheds, except that one of the pipes referred to runs along each set of machines. These pipes are supplied with small taps, fixed close together, and each tap has a glass tube, about the size of a gas burner, at the extreme point of which is a minute aperture through which the filament passes. These glass tubes are known as glass silkworms.

The effect of the pneumatic pressure in the cylinders referred to is to force the liquid matter not only along the iron tubes, but also, when the small taps are turned on, through each of the glass silkworms. It then appears as a scarcely perceptible globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and on to the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and on to the same bobbin. This done, she presses them together with her thumb and forefinger, at a certain point between the glass silkworms and the guides. Not only do they adhere, but thenceforward the filaments will continue to meet and adhere at that point, however long the machinery may be kept running. In this way the whole frame will soon be set at work, the threads not breaking until the bobbin is full, when they break automatically, while they are all of a uniform thickness. The new product is said to take dye much more readily than the natural silk. The chief difference in appearance between the natural and the artificial silk is in the greater luster of the latter. The *Times* says that the success secured by the new process in France is such that the introduction of the industry into Lancashire is expected to produce something like a revolution in trade, not only by bringing into existence a new occupation, but also by finding more work for weaving machinery in Manchester now only partially employed.

An objection to the use of this material which was made at the time the process was first announced was that it is much more inflammable than natural silk. However, it may be that this has been overcome. The substance in some respects resembles celluloid. The pulp from which the filaments are formed is a syrupy solution of cellulose.

TEN years ago there were but four tramway companies in Chicago, working a street mileage of 90 miles. To-day there are twenty-nine corporations engaged in local transportation business, operating 342 miles of street mileage. Of the four systems ten years ago, three were worked by horses, one using both cable and horses. Now there are:—Electric roads, 270 miles; cable roads, 42 miles; steam roads, 11 miles.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*6530. The Sperm Whale and Its Food. Frank T. Bullen (An extremely interesting account of personal observations upon this subject, including a description of a nocturnal combat between a sperm whale and a gigantic squid). Nature–June 4. 2700 w.

6539 The Effects of the St. Louis Tornado. Julius Baier (An examination of the affected district of interest to engineers owing to the numerous examples of the destructive power of the wind). Eng News–June 11. 1600 w.

*6551. The Penywern House Technical Col-

We supply copies of these articles. See introductory.

lege, Earl's Court (Description of buildings, course of study, physical laboratory, and machine shop, with illustrations). Engng–June 5. 1700 w.

6575. Cyclones and Tornadoes. John Lundie (An attempt to coördinate natural cyclonic conditions and phenomena with knowledge of action under similar artificial conditions). Elec Engng–June. 1500 w.

*6583. A Theory as to the Cause of the Phenomena Produced by the Röntgen Rays. R. C. Shettle (The writer briefly describes his theory of the nature and cause of gravity in order to clearly show his reasons for the theory presented). Elec Eng, Lond–June 5. 1500 w.

*6585. Röntgen Ray Experiments. Oliver J. Lodge (Facts determined by continued experiments). Elect'n–June 5. 1500 w.

*6598. High Explosives. H. F. Metcalf (Description of some explosives in use, giving their composition and chemical reactions when exploded, and an account of two recent explosives, Mellinite and Vixorite). Yale Sci M–June. 1700 w.

*6600. The United States Weather Bureau. E. T. Tefft (General popular description of the routine of service of observers). Yale Sci M–June. 1200 w.

6615. Salt Making. R. G. Collier (An interesting account of this industry in the Ohio Valley). Tradesman–June 15. 3700 w.

†6665. The Problem of the Tides, and the Limitations of the Present Solution of that Problem. John F. Hayford (A general study of the subject as a whole). Trans Assn of Civ Engs of Cornell Univ–June, '96. 9500 w.

*6722. The Cathode Rays Under the Influence of Strong Magnetic Forces (A brief illustrated account of the investigations of Herr Kr. Birkeland, published in the Norwegian *Elektroteknisk Tidsskrift*). Elec Rev, Lond–June 12. Serial 1st part. 2000 w.

*6723. The Röntgen Rays (The conclusions from an exhaustive series of experiments by Battelli, throwing much light on the origin of the Röntgen rays, and their relation to the cathode rays). Elec Rev, Lond–June 12. 1500 w.

6752. A Destroying Vacuum. John C. Barrows (Illustrated description of unexplained effects of the storm on different kinds of structures, many of which appear to have been the result of an exterior vacuum). Sci Am–June 27. 1700 w.

6761. The Shape of Crookes Tubes and Degree of Vacuum for Maximum Production of X-Rays (Article communicated to the French Academy of Sciences. Illustration of the tube found superior). Elec Eng–June 24. 500 w.

6771. Experiments with the Polarizing Photo-Chronograph to Determine the Motion of Projectiles Inside the Bore of a Gun. Albert C. Crehore and George O. Squier (Experiments described which were carried out at the U. S. Artillery School, Aug., 1895, with the objects of perfecting a practical chronograph suited to the needs of the military service, and to determine the adaptability of this instrument to the study of the motion of projectiles inside the bore. Elec Wld–June 27. Serial. 1st part. 2700 w.

6801. Experiments Showing the Permeability of Metallic Salts and Their Solutions by Röntgen Rays. Joseph F. Smith (Experiments, with illustrations, for the purpose of ascertaining whether the difference of permeability extends to the salts of the metals and to solutions of the salts in water). W Elec–June 27. 200 w.

6808. An Investigation with Röntgen Rays on Germinating Plants. H. J. Webber (Account of experiments). Science–June 26. 500 w.

6836. Science and Engineering. Thomas Curtis Clarke (Address at the annual convention at San Francisco, Cal., June 30, 1896. Showing the necessary relations and that they are becoming closer every day). Sci Am Sup–July 4. 3500 w.

6837. A Weather Bureau Kite. C. F. Marvin (Illustrated description of a kite used for meteorological observations). Sci Am Sup–July 4. 2400 w.

6844. On the Bleyer Photo Fluoroscope. J. Mount Bleyer (Description of an instrument which is practically an adaptation of the fluoroscope to the needs of the physician and surgeon, and consists in combining of instantaneous photography with the fluorescent screen). Elec Eng–July 1. 1600 w.

†6855. The Value of Leather Refuse. J. B. Lindsey (An account of experiments with conclusions and tabulated statements of results). Jour Am Chem Soc–July. 2000 w.

6860. The Olive. A. Taltavull (Its usefulness to mankind and interesting facts about its culture. The process of extracting oil from olives and preparing it for market is illustrated and described). Prog of Wld–July. 1700 w.

*6864. Some French Cement Works. H. K. Landis (Illustrated description of works and processes at and near Lafarge on the banks of the Rhone). Pav & Mun Eng–July. 1700 w.

†6929. The Difference Between "Islands" and "Upriver" Rubber (The value because of the lesser degree of shrinkage, better dried, the condition of cleanliness, greater yield, &c.) Ind Rub Wld–July 10. 1500 w.

†6930. The Demand for Balata and the Supply (The sources of supply and its merits as a substitute for gutta-percha). Ind Rub Wld–July 10. 900 w.

†6932. Rubber Prices and the Insulated-Wire Trade (Showing that high prices of rubber are not due to its use in the electrical field). Ind Rub Wld–July 10. 1400 w.

6949. Tesla Describes an Interesting Feature of the X-Ray Radiations (Observations made by Nikola Tesla, with bulbs emitting Röntgen radiations, throwing light on their nature and illustrating better properties already known). Elec Rev–July 8. 900 w.

6974. Obtaining the True Meridian by an Observation of the Sun. C. C. Hommann (The method herein described requires only a single observation of the sun. It is an old method, but having for a time been neglected, it appears now to be coming again into use). Eng News–July 9. 1600 w.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Barnes's Upright Drill.

THE cut illustrates this new design, which has recently been placed on the market in response to a demand for a drill intermediate in size between drills of 20-inch swing and 25-inch swing. The tool illustrated has 22½-inch swing, is very strong and stiff, and is a thoroughly-made, high-grade tool in every respect. Five styles of this drill are made at present, as follows:

(1) Without back-gear, and with hand-lever feed; (2) without back-gear, but having combined lever and worm feed; (3) back-geared, with hand-lever feed; (4) back-geared, with combined lever and worm feed; (5) back-geared, with self-feed, automatic stop, combined lever and worm feed. All these styles have quick return lever for the spindle. The spindle is fitted with No. 3 Morse taper.

The height of the drill is 74"; diameter of column, 6½"; diameter of spindle, 1½"; vertical travel of spindle, 11"; diameter of large pulley on cone, 10"; diameter of small pulley on cone, 4"; diameter of bevel gear, 7"; diameter of bevel pinion, 3½"; distance from spindle to base, 43".

The cones carry 3-inch belt and have four steps. The weight of the machine is 850 pounds. Counter shaft tight and loose pulleys should make 200 revolutions per minute.

This is one of the excellent tools manufactured by the W. F. and John Barnes Company, 953 Ruby street, Rockford, Ill.

Rosendale Hydraulic Cement.

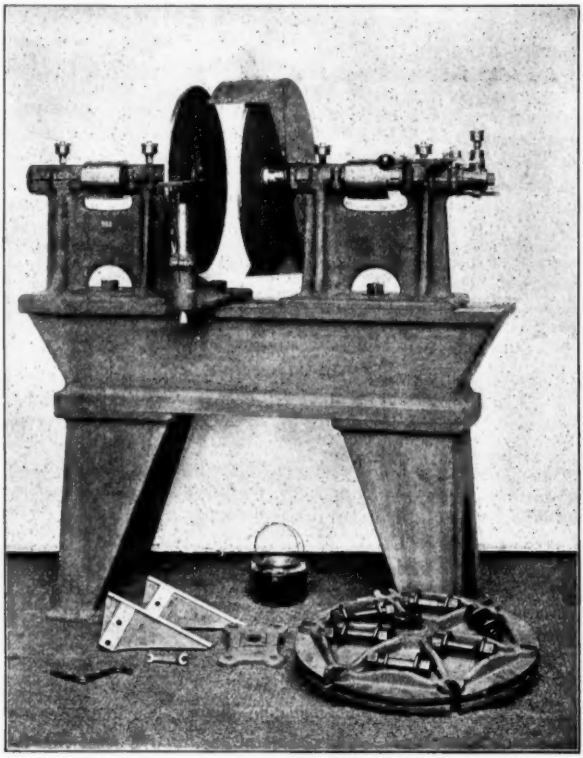
THE "Brooklyn Bridge" brand of Rosendale cement, manufactured by the New York and Rosendale Cement Company, 280 Broadway, New York, has acquired a wide and high reputation among American engineers, for its valuable qualities and sterling excellence.

It is guaranteed by the manufacturers to be of the highest grade, and has been used in the construction of a large number of the most important structures erected in the United States, among which the piers and other masonry of the Brooklyn bridge are typical. The high class work wherein this cement has been for years constantly employed, confirming its rank among the very best cements produced in the world. In its tensile and compression tests no cement surpasses it, and its hydraulic quality is perfect. It is dark in color, finely ground, and uniform; and the fact that it has been extensively used by the United States government would alone be a sufficient verification of these statements, were there not also an extensive and honorable record of other structures, all of which are important, wherein this cement has been employed with uniformly good results. The list of bridges, reservoirs, dams, buildings, piers, government work, etc., etc., which the manufacturers supply to inquirers, will be of interest to cement users, and to the engineering profession.

Another brand of Rosendale cement made by this company, highly esteemed for its uniform quality, and extensively used in New York, Brooklyn, and other eastern cities, is the "Hudson River" brand These cements are carefully packed in good well-papered barrels, each of which holds three hundred pounds.

The Gardner Grinder.

THE Gardner grinder is now being made with the two discs close together and parallel with each other. This new form is adapted to grinding two parallel and opposite faces such as, square headed screws, washers, spanner wrenches, etc. The work to be ground is placed between the disc wheels (one of which is movable) and is held on a rest between the wheels. The movable wheel is then brought up, grinding the side next to it, and also pressing the piece to be ground against the other wheel which grinds the opposite face. The disc wheels are of steel and ground flat. Work can be ground true on the Gardner grinder to the ten thousandth part of an inch. The cutting faces of the wheels are emery paper or cloth which are glued on the steel discs, and securely held in place by spiral grooves on each face of the disc. The cutting surface of the emery cloth sinks into the spiral groove, thus forming a clearance for the particles of emery and iron to fall into, and preventing these particles from rolling between the cutting face and the work and interfering with the cutting. This feature is claimed to make the Gardner grinder a faster cutter than any other, and it is further claimed that this grinder will do from two to ten times the work of a solid wheel in the same time. With the parallel discs as many as 800 square head set screws can be ground in



THE GARDNER GRINDER.

an hour, grinding the four sides of each head and making the opposte sides parallel.

This grinder is placed on the market by Charles H. Besly & Company, Nos. 10 and 12 North Canal street, Chicago, Ill.

Gas Furnaces for Hardening Dies and Cutters.

A STRIKING instance of sticking to old methods is found in the craft of toolmakers, many of whom still oppose the adoption of gas furnaces for hardening dies or cutters, because "there is nothing like a good charcoal fire," or good old-fashioned forge with a fan blower. How much good, excellent work has been done by the toolmaker only to be destroyed by a misapplication of heat! A good hardener and temperer enjoys a well-deserved importance in every machine shop, and his value to the firm depends upon the percentage of dies he can harden without loss. But even the best man will fall far short of the possible 100% if he sticks to coal and charcoal, and rejects gas as injurious to the steel. Gas heat is not only not injurious, but on the contrary is superior to other fuels, and positively beneficial to steel when properly used in a furnace adapted to the work; it will prove a most profitable innovation wherever there is work enough to pay for the cost of a good "heating tool."

The requirements for properly heating a steel die, milling cutter, or cutting blade, are as follows: (1) The heat applied must be just below the degree which would overheat the finest edge, rim, point, or other projection. (2) The heat must be uniformly distributed and under perfect control. (3) The atmosphere in the furnace should be non-oxidizing and under sufficient pressure to exclude air from the heating chamber.

In a measure; heated lead answers the purpose but even that should be kept at a uniform temperature, with gas used to heat the bath; while for tempering either in oil, lead, or zinc, steady work cannot be done when coal is used as fuel.

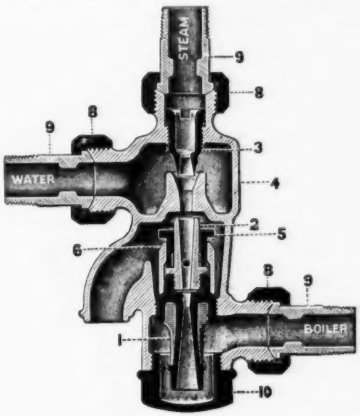
Gas furnaces, with any of the usual kinds of gas, always properly mixed near the point of combustion, with air under definite and positive pressure, should therefore receive the attention of all who wish to *systematize heating*, as well as other branches of their work, by the adoption of the best tools to be found.

The American Gas Furnace Company, of Elizabeth, N. J., with sales office at 80 Nassau street, N. Y., is a firm of practical mechanics which has built up a successful business from small beginnings by making "the economical and effective use of gas in the mechanic arts" an exclusive specialty. Intelligent devotion to its special line of work for over fifteen years has brought its gas-blast furnaces and "heating machines" to a notable degree of perfection, as also their "American Oil Gas Machine" for the automatic generation of an excellent fuel gas from naphtha. For any kind of work requiring accuracy in the application of heat we commend it to favorable notice.

New Automatic Restarting Injector.

THE cut herewith presented is a sectional view of a new automatic restarting injector, of which Messrs. Jenkins Brothers, of 71 John street, New York, are the selling agents.

This injector lately brought out by Wm. Sellers & Co., Inc., in Philadelphia, is designed for use on stationary and portable boilers, traction and hoisting engines, tug boats, etc. The house named has a high reputation for injectors for locomotive and other service. Their injectors are among the most perfect boiler feeders known, being the result of many years of careful



RESTARTING INJECTOR.

and scientific study and experiment to determine proportions and shapes that will give the widest possible range, with the most economical consumption of steam, and at the same time be perfectly reliable. In their system, when pipe sizes and proportions are once determined, they are strictly maintained by making parts to a perfect system of gaues; and, although an injector may have been in service until much worn, a new tube or part can be furnished that will fit perfectly and give exactly the same results as the

original. The injector is thoroughly automatic in every respect, and has as few parts as possible. There are no levers, and no fittings, except ordinary globe valves. Only a screw driver and a monkey wrench are required to take it apart for cleaning or renewal of parts. In designing, care has been exercised to obtain a wide range, to enable it to work hot water and to get maximum lift. There is no valve or other obstruction in the overflow, so that, when the injector is out of service, if the steam supply-valve should leak, there is no danger of heating the water in the service pipe to a very high temperature. Fourteen sizes are made, covering a range of from 2 to 400 h. p. The injector is meeting with great favor from steam users, and is, we believe, destined to become a leading injector in the market.

The Quimby Screw Pump.

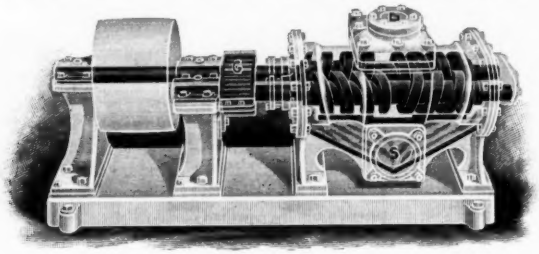
THE Quimby screw pump has no valves, no internal packing, and no pulsation in its delivery of any liquid. It is simple, compact, efficient, and durable.

Four screws, mounted in pairs on parallel shafts, act as pistons in propelling the water, and are so arranged that in each pair the thread of one screw projects to the bottom of the space between the threads of the opposite screws; the pump cylinder fitting closely the peripheries of the intermeshing threads.

Space enough is left between the faces of the intermeshing threads and between the faces of the threads and the cylinder to allow a close running fit without actual contact. The screws have no end thrusts in their bearings, because they receive the back pressure of the column of liquid in two opposite directions, so that the endwise pressure against the screws in one direction is counterbalanced by a like pressure in the reverse direction.

The suction connection at *S* opens into a chamber underneath the pump cylinder. The liquid drawn in passes through this chamber to the two opposite ends of the cylinder, from which points it is forced toward the center of the cylinder by the two pairs of intermeshing threads; discharging in the middle of the top of the cylinder as shown.

Driving power is applied directly to one of the shafts; the second shaft being driven by a pair of gears, *G*. The stuffing boxes only are packed, where the shafts pass through the cylinder head, and, being on the suction end, there is no tendency to blow out the packing.



QUIMBY SCREW PUMP.

The screws act on the liquid continuously with smooth and uniform delivery. The absence of pulsation increases efficiency, reduces pipe friction, and makes the pump peculiarly suitable for special purposes, such as pumping water in private houses, where the hammering effect of the pulsating delivery would be disagreeable; pumping into filter presses having metal screens; sprinkling the wire of a paper machine, or pumping into long pipe lines, such as oil lines, where a pulsating delivery makes it difficult to keep the pipe joints tight.

It is also an ideal pump for direct-connected electric work, when the pump and motor are mounted on the same bed-plate, with the motor shaft coupled directly to one of the pump shafts. Where a hydraulic elevator is operated by street pressure, a decided saving is effected in cost of operating by using this pump; and where the street pressure has fallen, or is unsteady, the elevator service is very much improved.

Where power is required for an elevator only, the electric pump does away with the high-pressure steam in the building, saves coal, obviates the need of a licensed engineer, and reduces the heat in the building during the summer. The Quimby Screw Pump is particularly well adapted to handling thick liquids, and especially for use in breweries, paper mills, etc. William E. Quimby, 59 Liberty street, New York city, the manufacturer, will respond to requests for catalogues or further information.

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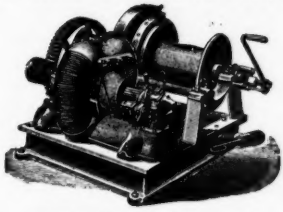

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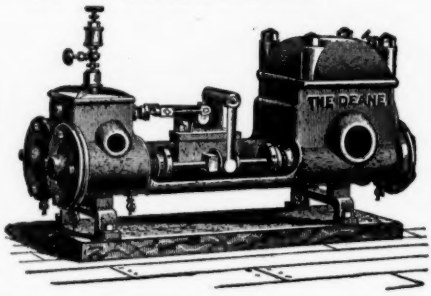

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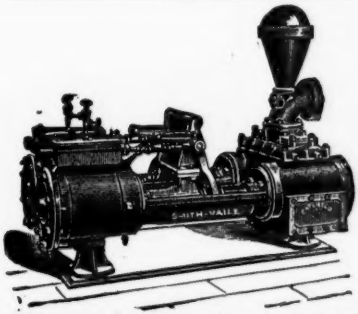

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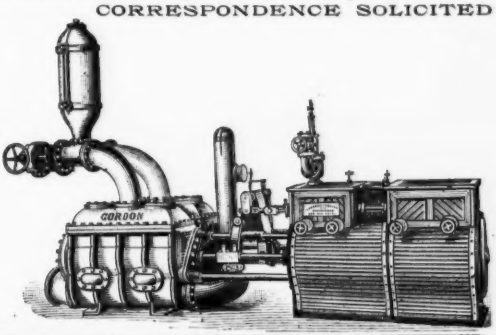

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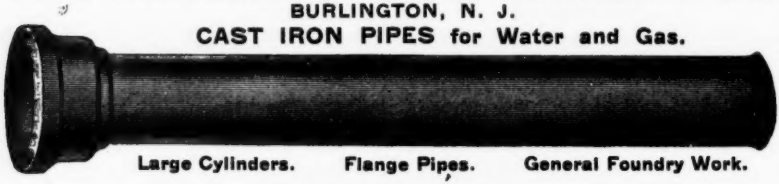

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